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AN EVALUATION OF TIME STUDY RATINGS OF A SYNTHETIC TASK

A Thesis

Submitted to the Faculty

of

Purdue University

by

Lawrence Stephen Lockett

In Partial Fulfillment of the

Requirements for the Degree

of

Master of Science in Industrial Engineering

June, 1950

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TABLE OF CONTENTS

Page

LIST OF TABLES.....	
LIST OF FIGURES.....	
ABSTRACT.....	
INTRODUCTION.....	1
OBJECT.....	5
PROCEDURE	
Part A: Before the collection of the data.....	7
Part B: The collection of data.....	9
Part C: Analyzing the data.....	10
CONCLUSIONS.....	12
APPENDIX A. TABLES AND FIGURES.....	16
APPENDIX B. MATHEMATICAL PROCEDURES.....	87
BIBLIOGRAPHY.....	92

LIST OF TABLES.....	1
LIST OF FIGURES.....	2
ABBREVIATIONS.....	3
INTRODUCTION.....	4
CHAPTER I.....	5
CHAPTER II.....	6
CHAPTER III.....	7
CHAPTER IV.....	8
CHAPTER V.....	9
CHAPTER VI.....	10
CHAPTER VII.....	11
CHAPTER VIII.....	12
CHAPTER IX.....	13
CHAPTER X.....	14
CHAPTER XI.....	15
CHAPTER XII.....	16
CHAPTER XIII.....	17
CHAPTER XIV.....	18
CHAPTER XV.....	19
CHAPTER XVI.....	20
CHAPTER XVII.....	21
CHAPTER XVIII.....	22
CHAPTER XIX.....	23
CHAPTER XX.....	24
CHAPTER XXI.....	25
CHAPTER XXII.....	26
CHAPTER XXIII.....	27
CHAPTER XXIV.....	28
CHAPTER XXV.....	29
CHAPTER XXVI.....	30
CHAPTER XXVII.....	31
CHAPTER XXVIII.....	32
CHAPTER XXIX.....	33
CHAPTER XXX.....	34
CHAPTER XXXI.....	35
CHAPTER XXXII.....	36
CHAPTER XXXIII.....	37
CHAPTER XXXIV.....	38
CHAPTER XXXV.....	39
CHAPTER XXXVI.....	40
CHAPTER XXXVII.....	41
CHAPTER XXXVIII.....	42
CHAPTER XXXIX.....	43
CHAPTER XL.....	44
CHAPTER XLI.....	45
CHAPTER XLII.....	46
CHAPTER XLIII.....	47
CHAPTER XLIV.....	48
CHAPTER XLV.....	49
CHAPTER XLVI.....	50
CHAPTER XLVII.....	51
CHAPTER XLVIII.....	52
CHAPTER XLIX.....	53
CHAPTER L.....	54
CHAPTER LI.....	55
CHAPTER LII.....	56
CHAPTER LIII.....	57
CHAPTER LIV.....	58
CHAPTER LV.....	59
CHAPTER LVI.....	60
CHAPTER LVII.....	61
CHAPTER LVIII.....	62
CHAPTER LIX.....	63
CHAPTER LX.....	64
CHAPTER LXI.....	65
CHAPTER LXII.....	66
CHAPTER LXIII.....	67
CHAPTER LXIV.....	68
CHAPTER LXV.....	69
CHAPTER LXVI.....	70
CHAPTER LXVII.....	71
CHAPTER LXVIII.....	72
CHAPTER LXIX.....	73
CHAPTER LXX.....	74
CHAPTER LXXI.....	75
CHAPTER LXXII.....	76
CHAPTER LXXIII.....	77
CHAPTER LXXIV.....	78
CHAPTER LXXV.....	79
CHAPTER LXXVI.....	80
CHAPTER LXXVII.....	81
CHAPTER LXXVIII.....	82
CHAPTER LXXIX.....	83
CHAPTER LXXX.....	84
CHAPTER LXXXI.....	85
CHAPTER LXXXII.....	86
CHAPTER LXXXIII.....	87
CHAPTER LXXXIV.....	88
CHAPTER LXXXV.....	89
CHAPTER LXXXVI.....	90
CHAPTER LXXXVII.....	91
CHAPTER LXXXVIII.....	92
CHAPTER LXXXIX.....	93
CHAPTER LXXXX.....	94
CHAPTER LXXXXI.....	95
CHAPTER LXXXXII.....	96
CHAPTER LXXXXIII.....	97
CHAPTER LXXXXIV.....	98
CHAPTER LXXXXV.....	99
CHAPTER LXXXXVI.....	100

TABLES

Table	Page
1. Tabulation of numerical results of all categories	
a. Computed for accuracy.....	17
b. Computed for consistency.....	18
2. Tabulation of entire group data.	
a. Computed for accuracy.....	19
b.. Computed for consistency.....	20
3. Tabulation of northern mid-west area, less Michigan, data.	
a. Computed for accuracy.....	21
b. Computed for consistency.....	22
4. Tabulation of central mid-west area data.	
a. Computed for accuracy.....	23
b. Computed for consistency.....	24
5. Tabulation of southern mid-west area data.	
a. Computed for accuracy.....	25
b. Computed for consistency.....	26
6. Tabulation of Michigan area data.	
a. Computed for accuracy.....	27
b. Computed for consistency.....	28
7. Tabulation of data for experience, 0-6 months.	
a. Computed for accuracy.....	29
b. Computed for consistency.....	30
8. Tabulation of date for experience, 6 months-2 years	
a. Computed for accuracy.....	31
b. Computed for consistency.....	32

Table

Table

1. Tabulation of numerical results of all categories	
a. Computed for accuracy.....	17
b. Computed for consistency.....	18
2. Tabulation of entire group data.	
a. Computed for accuracy.....	19
b. Computed for consistency.....	20
3. Tabulation of northern mid-west area, Iowa	
Michigan, data.	
a. Computed for accuracy.....	21
b. Computed for consistency.....	22
4. Tabulation of central mid-west area data.	
a. Computed for accuracy.....	23
b. Computed for consistency.....	24
5. Tabulation of southern mid-west area data.	
a. Computed for accuracy.....	25
b. Computed for consistency.....	26
6. Tabulation of Michigan area data.	
a. Computed for accuracy.....	27
b. Computed for consistency.....	28
7. Tabulation of data for experience, 0-8 months.	
a. Computed for accuracy.....	29
b. Computed for consistency.....	30
8. Tabulation of data for experience, 9 months-2 years	
a. Computed for accuracy.....	31
b. Computed for consistency.....	32

Table	Page
9. Tabulation of data for experience, 2-4 years.	
a. Computed for accuracy.....	33
b. Computed for consistency.....	34
10. Tabulation of data for experience, over 4 years.	
a. Computed for accuracy.....	35
b. Computed for consistency.....	36
11. Tabulation of data for education, college.	
a. Computed for accuracy.....	37
b. Computed for consistency.....	38
12. Tabulation of data for education, company	
a. Computed for accuracy.....	39
b. Computed for consistency.....	40
13. Tabulation of data in which rater uses his own concept of standard performance.	
a. Computed for accuracy.....	41
b. Computed for consistency.....	42
14. Tabulation of data in which rater uses some film or other embodiment of standard performance.	
a. Computed for accuracy.....	43
b. Computed for consistency.....	44
15. Tabulation of data for plant employing less than 101 men.	
a. Computed for accuracy.....	45
b. Computed for consistency.....	46

8.	Tabulation of data for experience, 3-4 years.	
a.	Computed for accuracy.....	33
b.	Computed for consistency.....	34
10.	Tabulation of data for experience, over 4 years.	
a.	Computed for accuracy.....	35
b.	Computed for consistency.....	36
11.	Tabulation of data for education, college.	
a.	Computed for accuracy.....	37
b.	Computed for consistency.....	38
12.	Tabulation of data for education, company.	
a.	Computed for accuracy.....	39
b.	Computed for consistency.....	40
13.	Tabulation of data in which rater uses his own concept of standard performance.	
a.	Computed for accuracy.....	41
b.	Computed for consistency.....	42
14.	Tabulation of data in which rater uses some film or other embodiment of standard performance.	
a.	Computed for accuracy.....	43
b.	Computed for consistency.....	44
15.	Tabulation of data for plant employing less than 101 men.	
a.	Computed for accuracy.....	45
b.	Computed for consistency.....	46

16.	Tabulation of data for plant employing 101-1000 men.	
a.	Computed for accuracy.....	47
b.	Computed for consistency.....	48
17.	Tabulation of data for plant employing more than 1000 men.	
a.	Computed for accuracy.....	49
b.	Computed for consistency.....	50
18.	Tabulation of data for size of city less than 5,000.	
a.	Computed for accuracy.....	51
b.	Computed for consistency.....	52
19.	Tabulation of data for size of city, 5000-10,000.	
a.	Computed for accuracy.....	53
b.	Computed for consistency.....	54
20.	Tabulation of data for size of city, 10,000-25,000.	
a.	Computed for accuracy.....	55
b.	Computed for consistency.....	56
21.	Tabulation of data for size of city, 25,000-50,000.	
a.	Computed for accuracy.....	57
b.	Computed for consistency.....	58
22.	Tabulation of data for size of city, 50,000-100,000.	
a.	Computed for accuracy.....	59
b.	Computed for consistency.....	60
23.	Tabulation of data for size of city, greater than 100,000.	
a.	Computed for accuracy.....	61
b.	Computed for consistency.....	62

15.	Tabulation of data for plants employing 101-1000 men.	
a.	Computed for accuracy.	47
b.	Computed for consistency.	48
17.	Tabulation of data for plant employing more than 1000 men.	
a.	Computed for accuracy.	49
b.	Computed for consistency.	50
16.	Tabulation of data for size of city less than 2,000.	
a.	Computed for accuracy.	51
b.	Computed for consistency.	52
18.	Tabulation of data for size of city, 2000-10,000.	
a.	Computed for accuracy.	53
b.	Computed for consistency.	54
19.	Tabulation of data for size of city, 10,000-25,000.	
a.	Computed for accuracy.	55
b.	Computed for consistency.	56
20.	Tabulation of data for size of city, 25,000-50,000.	
a.	Computed for accuracy.	57
b.	Computed for consistency.	58
21.	Tabulation of data for size of city, 50,000-100,000.	
a.	Computed for accuracy.	59
b.	Computed for consistency.	60
22.	Tabulation of data for size of city, greater than 100,000.	
a.	Computed for accuracy.	61
b.	Computed for consistency.	62

FIGURES

Figure	Page
1. Graph of overall data.....	64
2. Graph of northern mid-west, less Michigan, data.....	65
3. Graph of central mid-west area data.....	66
4. Graph of southern mid-west area data.....	67
5. Graph of Michigan area data.....	68
6. Graph of data for experience, 0-6 months.....	69
7. Graph of data for experience, 6 months-2 years.....	70
8. Graph of data for experience, 2-4 years.....	71
9. Graph of data for experience, over 4 years.....	72
10. Graph of data for education, college.....	73
11. Graph of data for education, company.....	74
12. Graph of data in which rater uses his own concept of standard performance.....	75
13. Graph of data in which rater uses a film or some other embodiment of standard performance.....	76
14. Graph of data for plant employing less than 101 men...	77
15. Graph of data for plant employing 101-1000 men.....	78
16. Graph of data for plant employing more than 1000 men..	79
17. Graph of data for size of city less than 5,000.....	80
18. Graph of data for size of city, 5,000-10,000.....	81
19. Graph of data for size of city, 10,000-25,000.....	82
20. Graph of data for size of city, 25,000-50,000.....	83
21. Graph of data for size of city, 50,000-100,000.....	84
22. Graph of data for size of city greater than 100,000...	85
23. Job description of the synthetic task.....	86

FIGURES

Figure	Page
1. Graph of overall data.....	64
2. Graph of northern mid-west, Lake Michigan, data.....	65
3. Graph of central mid-west area data.....	66
4. Graph of southern mid-west area data.....	67
5. Graph of Michigan area data.....	68
6. Graph of data for experience, 0-5 months.....	69
7. Graph of data for experience, 6 months-1 year.....	70
8. Graph of data for experience, 1-4 years.....	71
9. Graph of data for experience, over 4 years.....	72
10. Graph of data for education, college.....	73
11. Graph of data for education, company.....	74
12. Graph of data in which water runs his own company of	
standard performance.....	75
13. Graph of data in which water runs a firm in some other	
category of standard performance.....	76
14. Graph of data for plant employing less than 101 men...	77
15. Graph of data for plant employing 101-1000 men.....	78
16. Graph of data for plant employing more than 1000 men...	79
17. Graph of data for size of city less than 5,000.....	80
18. Graph of data for size of city, 5,000-10,000.....	81
19. Graph of data for size of city, 10,000-25,000.....	82
20. Graph of data for size of city, 25,000-50,000.....	83
21. Graph of data for size of city, 50,000-100,000.....	84
22. Graph of data for size of city greater than 100,000...	85
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ABSTRACT

Rating is a process in which we relate observed performance to a designated concept of standard. This process is usually carried out to determine the "standard time". Performing the job in the standard time is called "standard performance".

There are two major methods of rating,

- (1) methods using a mathematical formula,
- (2) methods using judgement.

The mathematical formula methods are not considered as being accurate and are not in general use. Industry largely makes use of those methods involving judgement on the part of the rater.

Time study engineers in industry today have been on the job various lengths of time; have received their time study education from various sources, and utilize different concepts of "standard performance". It is believed that their accuracy in rating is affected by these and other factors such as area of employment, size of plant, as reflected in number of employees, and size of city in which plant is located. The objective of this thesis was to determine if any or all of these factors affect the accuracy and consistency of the ratings made by a typical group of time study engineers from the Mid-West region. This was accomplished by analyzing the ratings of job films in accordance with the following breakdowns:

Rating is a process in which an entire observed portion
 is rated as a designated number of standards. This process is
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 cated. The objective of this thesis was to determine if any
 or all of these factors affect the accuracy and consistency
 of the ratings made by a typical group of time study engineers
 from the mid-west region. This was accomplished by analyzing
 the ratings of job time in accordance with the following

procedures:

1. Entire group.
2. Area.
3. Experience.
4. Initial source of time study training.
5. Concept of "standard performance".
6. Size of plant.
7. Size of city in which plant is located.

With the engineers assembled in a room, films of an operator performing a synthetic task were projected. The job was a simple laboratory operation, representative of light factory work. The films were divided into 12 loops with the operator working at a different pace in each loop. Loops were projected in a random order of pace. Engineers were instructed to rate by cycle and to employ any method of rating that they desired. Method of performing the job was stipulated to be correct. In order to place all ratings on a mutually comparable basis and to simplify the mathematical problem, Rating Conversion Scales were used by each man to convert his raw rating to that figure he would have assigned had he assumed 130 to be the maximum numerical value he would expect of the typical operator in his plant.

Conclusions.

An analysis of the results of a group of typical time study engineers when rating job films leads to the following conclusions:

1. Time study experiments tend to rate too high at the

lower rates and too low at the higher rates.

2. The line best fitted, by mathematical means, to all

points for the entire group, suggests the trend of this group,

on the average, to be outside the $\pm 5\%$ level at values below

about 95; the $\pm 10\%$ level at values below about 75; the -25%

level at values greater than 125; the -10% level at values

in excess of 220.

3. Area. The area in which the plant is located has,

apparently, little or no effect on accuracy.

4. Experience. It is suggested that at least 6 months

experience is required to make the qualified time study

engineer but that accuracy then remains about the same

with increased experience.

5. Education. The data suggests, at least for this

group, at the higher level of accuracy, i. e. $\pm 5\%$, initial

source of time study training does not affect accuracy. At

a less rigid degree of accuracy, i. e. $\pm 10\%$, those who re-

ceived their initial time study training from the company

rate a little more accurately. This may not be true of

those receiving modern training from either school or

company.

6. Concept of "standard performance". It is suggested

that tests which are a little or some other embodiment of stan-

dard performance are more accurate than those using their

own concept.

7. Size of plant. Size of plant apparently has little

or no relationship to accuracy.

8. Size of city. Size of city in which the plant is located apparently has little or no bearing on the raters' accuracy.

9. Consistency followed by the same direction as accuracy in all cases. It was, however, slightly higher. This was to be expected from the manner in which the data were handled.

This analysis suggests that when rating a job film we can probably expect of time study engineers, in terms of the percentage of personnel within limits indicated, the following degrees of accuracy:

- +5% level: more than one third---38%.
- +7½% level: almost one half-----48%.
- +10% level: almost two thirds-----62%.
- +20% level: the great majority----86%.

8. Size of city. Size of city in which the plant is located apparently has little or no bearing on the relative economy.

9. Job history followed by the same direction as economy in all cases. It was, however, slightly lighter. This was to be expected from the manner in which the data were handled.

This analysis suggests that when rating a job film we can probably expect of time study engineers, in terms of the percentage of personnel within limits indicated, the following degrees of economy:

- ±10% level: the great majority---50%.
- ±15% level: almost two thirds---67%.
- ±20% level: almost one half---50%.
- ±25% level: more than one third---33%.

AN EVALUATION OF TIME STUDY RATINGS OF A SYNTHETIC TASK

INTRODUCTION

"Motion and time study refers to the analysis of the work and time necessary to do a certain job".¹ To find the time necessary we usually resort to a stop watch time study. A stop watch time study is accomplished by observing an operator performing the task and recording the time obtained. However, we note that if we should time another operator performing identically the same job, in the same manner, we very probably would obtain a different time of accomplishment. And if we studied a third operator we might get a third value of time. The question now arises, "which one of these workers is performing the task in the correct amount of time"? The answer to this question is required to establish a "standard time" for the job in question. Performing the job in the standard time is called "standard performance".

One definition of standard time given by Mundel² is, "the time necessary to do a certain job, defined as to method and conditions surrounding the work, by a operator physically fit for the job as the typical operator who could be expected on the job, possessing sufficient skill to do

1 M. E. Mundel, Systematic Motion and Time Study, p. 3, Prentice-Hall, Inc., New York, 1947.

2 Ibid., p. 147.

INTRODUCTION

Position and time study refers to the analysis of the work and time necessary to do a certain job. To find the time necessary to usually resort to a stop watch time study. A stop watch time study is accomplished by observing an operator performing the task and recording the time observed. However, we note that if we should time another operator performing identically the same job, in the same manner, we very probably would obtain a different time of accomplishment. And if we should a third operator we might get a third value of time. The question now arises, "which one of these workers is performing the task in the correct amount of time?" The answer to this question is required to establish a "standard time" for the job in question. Performing the job in the standard time is called "standard performance".

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L. J. Munroe, Systematic Motion and Time Study, p. 3, Prentice-Hall, Inc., New York, 1947.

the job properly, adapted to the job, and working at a pace 100/130 of the maximum he could maintain for the working day without harmful physical effects". But with all of these conditions understood and defined, it is still necessary to determine what relationship the performance of the operator observed bears to the pace defined as standard. The process of relating observed performance to a designated standard is called "rating", and further discussion will be confined to this subject.

There are two major methods of rating,

- (1) methods using a mathematical formula,
- (2) methods using judgement.
 - (a) Multiple factor systems,
 - (b) single factor systems.

Because of the great number of variables affecting the operators time the mathematical formula methods are not considered as being accurate, are not in general use, and will not be considered here.

An example of the judgement method is the "effort" rating plan. This plan involves two steps,

- (1) judge the difficulty of the job and imagine a concept of reasonable performance,
- (2) compares what he sees to this concept.

To carry out this method the time study man should be familiar with the visible appearance of the steps in the range of effort, as reflected in pace, on each type of job he ob-

the job properly, assigned to the job, and working at a pace
100% of the maximum he would maintain for the working day
without normal physical effort. But with all of these
conditions understood and defined, it is still necessary to
determine what relationship the performance of the operator
observed bears to the pace defined as standard. The process
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(1) Judge the difficulty of the job and assign a

constant of reasonable performance,

(2) compare what he does to this constant.

To carry out this method the first step is to assign the

first with the visible appearance of the steps in the range

of effort, as reflected in pace, on each type of job he ob-

serves.³ In a plant with a variety of jobs this is not always feasible.

Now judgement must involve the determination of the effect of the operator's skill, aptitude, and effort on his performance. The system advanced by Mundel⁴ accomplishes the above and entails the following steps on the part of the rater,

(1) compares the workers pace to a fixed concept of speed,

(2) adjusts the observed value for difficulty of the job.

It becomes obvious that a standard pace must be defined. The standard pace may be a man walking on a level at 3 miles per hour. Also it could be a person dealing a deck of cards into 4 equal stacks in one half of a minute.⁵ It is evident some value or representation of pace must be made in order that judgement of pace be possible and effective. A physical embodiment of this designated pace could be a film of an operator walking or dealing cards at the respective rates indicated above. Some time study men have their own concept of standard performance and some utilize a film as previously mentioned. When using the Presgrave⁵ system a different concept of the standard pace for each job is required.

3 Ibid., p. 157.

4 Mundel, op. cit., p. 157.

5 Ralph Presgrave, Dynamics of Time Study, 2nd ed., p. 154, McGraw Hill Book Co., Inc., New York, 1945.

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 equivalent of this designated pace could be a film of an
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 indicated above. Some time study men have their own concept
 of standard performance and some utilize a film as previously
 mentioned. When using the Progressive⁶ system a different con-
 cept of the standard pace for each job is required.

⁵ Ibid., p. 157.

⁴ Lippitt, op. cit., p. 157.

⁶ Ralph F. Stagner, Progressive, Principles of Time Study, 2nd ed.,
 p. 154, Western Hill Book Co., Inc., New York, 1942.

Rating may be expressed as points per hour⁶ or as a percentage figure. Percentage numbers are more widely used and will be employed in this thesis. There are various percentage systems in use but the following will be employed here: the maximum performance that could be expected of the typical worker, for the entire working day, without harmful physical effects will be 130 and standard performance will be 100/130 of this value.

To adjust for difficulty of performance on different jobs, tables are prepared with certain allowances for adjustment purposes.

Time study engineers in industry today have been on the job various lengths of time; have received their time study education from various sources, and utilize different concepts of "standard performance". It is believed that their accuracy in rating is affected by these and other factors such as area of employment, size of plant, size of city in which the plant is located.

⁶ Ralph M. Barnes, Motion and Time Study, 3rd ed., p. 353, John Wiley & Sons, Inc., New York, 1949.

...and will be employed in this capacity. There are various
 performance figures. Performance figures are not strictly used
 and will be employed in this capacity. There are various
 performance figures in use and the following will be employed
 here: The various performance figures should be expected of the
 typical worker, for the entire working day, without detailed
 statistical effects will be 120 and standard performance will
 be 100/120 of this value.

To express the difficulty of performance of different
 jobs, figures are prepared with certain allowances for major
 least important. The study engineers in industry today have been on the
 job various times of time; have reviewed their own work
 education the various workers, and utilize different con-
 cepts of "standard performance". It is believed that factor
 technology in rating is affected by these and other factors
 such as size of employment, size of plant, size of city in
 which and time is located.

OBJECT

The object of this thesis is to determine if any or all of these aforementioned factors affect the accuracy and consistency of ratings made by typical group of time study engineers from the Mid-West region. This object will be investigated by analyzing the ratings of job films in accordance with the following breakdowns:

1. Entire group.
2. Area.
 - a. Northern Mid-West, less Michigan.
 - b. Central Mid-West.
 - c. Southern Mid-West.
 - d. Michigan.
3. Experience.
 - a. 0-6 months.
 - b. 6 months - 2 years.
 - c. 2-4 years.
 - d. Over 4 years.
4. Initial source of time study training.
 - a. College.
 - b. Company.
5. Concept of "standard performance".
 - a. Rater uses own concept.
 - b. Rater uses a film or some other embodiment.
6. Size of plant, (number of employees).
 - a. 0-101 men.
 - b. 101-1000 men.

OBJECT

The object of this thesis is to determine if any or all of these aforementioned factors affect the accuracy and consistency of ratings made by typical group of time study engineers from the mid-west region. This object will be investigated by analyzing the ratings of job films in accordance with the following breakdowns:

1. Entire group.
2. Area.
 - a. Northern Mid-West, Iowa-Michigan.
 - b. Central Mid-West.
 - c. Southern Mid-West.
 - d. Michigan.
3. Experience.
 - a. 0-6 months.
 - b. 6 months - 2 years.
 - c. 2-4 years.
 - d. Over 4 years.
4. Initial source of time study training.
 - a. College.
 - b. Company.
5. Concept of "standard performance".
 - a. Rater uses own concept.
 - b. Rater uses a film or some other embodiment.
6. Size of plant, (number of employees).
 - a. 0-100 men.
 - b. 101-1000 men.

- c. Over 1000 men.
- 7. Size of city in which plant is located.
 - a. Under 5000.
 - b. 5000-10000.
 - c. 10000-25000.
 - d. 25000-50000.
 - e. 50000-100000.
 - f. Over 100000.

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1. The first of these is the fact that the Commission has not yet received any information from the Government of the United States regarding the results of its investigation of the activities of the American Friends of the Soviet Union.

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PROCEDURE-PART A

In order to carry out the objectives of this thesis it was necessary to have a typical group of time study engineers rate a task or a number of tasks. To obtain this data Industrial Engineers from various firms located in Indiana, Illinois, Michigan, Ohio, and Wisconsin were invited to attend a "work session" at Purdue University on the 15th of March, 1950.

Data could have been obtained by having the raters view either a film of an operator performing a task or view an actual operator. For various reasons a film was chosen rather than an operator. Some of these reasons are:

1. A film was already available thus obviating the necessity of training an operator.
2. A film is more convenient as it can be viewed by a much larger group than could an operator working at a task.
3. Method and skill can be maintained more consistently and accurately by means of a film since many operators are distracted when performing in the presence of an audience.
4. It was shown by Margolin⁷ that time study engineers rate more accurately and consistently from a job film than from an operator.

The film selected consisted of an operator performing a simple task, a job description of which is appended. The

⁷ Louis Margolin, "A Comparison of Two Methods of Presentation For Time Study Ratings", Unpublished Masters Thesis, Purdue University, 1948.

In order to carry out the objectives of this thesis it was necessary to have a typical group of line shop employees take a task of a number of hours. To obtain this data for electrical Engineers from various firms located in Indiana, Illinois, Michigan, Ohio, and Wisconsin were invited to attend a "work session" at Purdue University on the 15th of March, 1950.

Data could have been obtained by having the subjects view either a film of an operator performing a task or view an actual operator. For various reasons a film was chosen rather than an operator. Some of these reasons are:

1. A film was already available thus obviating the necessity of training an operator.
2. A film is more convenient as it can be viewed by a much larger group than could an operator working at a task.
3. Speed and skill can be maintained more consistently and accurately by means of a film since many operators are distracted when performing in the presence of an audience.
4. It was shown by Margolin⁷ that time study engineers rate more accurately and consistently from a job film than from an operator.

The film selected consisted of an operator performing a simple task, a job description of which is appended. The

⁷ Louis Margolin, "A Comparison of Two Methods of Time Study Rating the Time Study Rating", Unpublished Masters Thesis, Purdue University, 1948.

film was prepared in 1949 under the supervision of Lehrer.⁸

It was divided into 36 parts in which the operator performed at a different pace in each part. The film had been carefully edited to eliminate any fumbles, false movements or any other irregularities. Considerations involved in the selection of this film were:

1. It involves sharp clear motions and elements.
2. Includes motions of the hands and arms that are typical of light factory work.

Twelve loops were prepared from the film. They were carefully checked to insure that the ratio between the elements of a given loop in each cycle were the same. Loops were arranged in a random order of pace for projection purposes.

It being realized that different time study men utilize different numerical maximum percentage values as expectable of the typical worker, rating conversion scales were prepared for their use. In this manner they could convert their raw rating to the one in which 130 represents the typical maximum.

Two IBM mark sensing cards were prepared for issuance to each man. These cards were punched with identifying data for each man. It was arranged that each man would then enter his "converted rating" directly on the IBM cards.

⁸ R. N. Lehrer, "Development and Evaluation of a Pace Scale for Time Study Rating", Unpublished Doctors Thesis, Purdue University, 1949.

This was prepared in 1942 under the supervision of Langer.
It was divided into 25 parts in which the operator examined
at a different time in each part. The film had been carefully
edited to eliminate any possible false statements or any other
irregularities. Considerations involved in the selection of
this film were:

1. It involves sharp clear motions and statements.
2. Inclusive action of the hands and arms that are
typical of light factory work.

Twelve loops were prepared from the film. They were
carefully checked to insure that the ratio between the ele-
ments of a given loop in each cycle were the same. Loops were
arranged in a random order of pace for projection purposes.
It being realized that different time study men utilize
different numerical extreme percentage values as expected
of one typical worker, rating conversion scales were prepared
for their use. In this manner they could convert their re-
sults to the one in which 130 represents the typical maximum.
The 130 rank rating cards were prepared for issuance
to each man. These cards were punched with identifying data
for each man. It was arranged that each man would not enter
his "converted rating" directly on the 130 cards.

PROCEDURE-PART B

The engineers assembled in the lecture room of the Electrical Engineering building and after a greeting by Dr. M. E. Mundel, Professor of Industrial Engineering, General Engineering Department, Purdue University, a questionnaire was handed out to each man. This questionnaire was for the purpose of collecting information for the thesis of Borrus.⁹ It further served the purpose of procuring the necessary information such as area, experience, etc., of each man for this thesis.

On completion of the questionnaire the IBM mark sensing cards, special pencils, rating conversion scales, were issued to each man. Instructions for their use was given.

Engineers were requested to rate by cycle, using their own system of rating. Method of the job was stipulated to be correct. They were further reminded to use the rating conversion scales in order that all ratings would be on a mutually comparable basis.

A loop was projected for a short time to familiarize each man with the method of the job. On completion of this showing the session began. Loops were projected at the same speed at which they were made. About 2 minutes were allowed for projection and about 1 minute for recording of ratings. This procedure was continued until all 12 paces were shown.

⁹ Bernard S. Borrus, "The Present State of Time Study", Unpublished Masters thesis, Purdue University, 1950.

The experiment was held in the lecture room of the
Department of Engineering Building and after a meeting by Dr.
W. E. Bennett, Professor of Industrial Engineering, General
Engineering Department, Purdue University, a questionnaire
was handed out to each man. This questionnaire was for the
purpose of collecting information for the thesis of Purdue.
It further served the purpose of procuring the necessary
information such as size, experience, etc., of each man for
this study.

The completion of the questionnaire and the work handling
only, special details, having been given, were handed
to each man. Instructions for their use were given.
Subjects were requested to rate by cycle, using their
own system of rating. Method of the job was explained to be
correct. They were further permitted to use the rating com-
parison scales in order that all ratings would be on a
usually comparable basis.

A loop was projected for a short time to familiarize
each man with the method of the job. On completion of this
session the session began. Loops were projected at the rate
of about 100 per minute. About 5 minutes were allowed
for projection and about 1 minute for recording of ratings.
This procedure was continued until all 15 pairs were shown.

PROCEDURE-PART C

After all 12 paces had been rated the IBM cards were delivered to the IBM Computing Laboratory where all necessary data were punched on the cards. The IBM Laboratory supplied the following information for each pace and for each category of breakdown:

1. Number of raters.
2. Totals of their scores.
3. All ratings made.
4. Number of raters with a specific score.

With this information, corrected values for each pace was determined. Mathematical procedure for determining this is contained in Appendix B. With the corrected value of each pace obtained, and the information from IBM, analyzation for accuracy was made by noting the number and percentage of raters within $\pm 5\%$, $\pm 7\frac{1}{2}\%$, $\pm 10\%$, $\pm 20\%$ of the corrected values for each pace and for each category of breakdown.

To analyze for consistency, the same procedure was employed except the average of the raters' values was used as the measure about which the variation was appraised.

To arrive at conclusions the data were investigated by inspection and by the "analysis-of-variance" technique. The analysis-of-variance technique was employed at the $\pm 5\%$ and $\pm 10\%$ level of accuracy in all cases and at the $\pm 20\%$ in a few. Appendix B has a short discussion on the analysis-of-variance technique.

PROCEDURE - PART 2

After all 18 hours had been tested the 180 cards were delivered to the IBM Computing Laboratory where all necessary data were punched on the cards. The IBM Laboratory supplied the following information for each case and for each category of breakdown:

1. Number of rats.
 2. Total of their scores.
 3. All ratings made.
 4. Number of rats with a specific score.
- With this information, corrected values for each case was determined. Mathematical procedure for determining this is contained in Appendix B. With the corrected value at each case obtained, and the information from IBM, analysis for accuracy was made by noting the number and percentage of rats within $\pm 5\%$, $\pm 10\%$, $\pm 15\%$ of the corrected values for each case and for each category of breakdown.

To analyze for consistency, the same procedure was employed except the average of the rats' values was used as the measure about which the variation was expressed.

To arrive at conclusions the data were investigated by inspection and by the "analysis-of-variance" technique. The analysis-of-variance technique was employed at the $\pm 5\%$ and $\pm 10\%$ level of accuracy in all cases and at the $\pm 15\%$ in a few. Appendix C has a short discussion on the analysis-of-variance technique.

Raters' averages were plotted against the corrected values for each category of breakdown. A line, determined by the method of "least squares", was drawn through these points. This line indicated the points at which raters tended to depart from the $\pm 5\%$ and $\pm 10\%$ levels of accuracy. Appendix B contains a short discussion on the "least squares" method of fitting a curve through a set of points.

values for each category of observation. A line, determined
 by the method of "least squares", was drawn through these
 points. This line indicated the points at which values
 tended to depart from the $\pm 10\%$ levels of accuracy.
 Appendix B contains a short discussion on the "least squares"
 method of fitting a curve through a set of points.

CONCLUSIONS

An analysis of the results of a group of typical time study engineers, when rating job films of various paces, leads to the following conclusions:

1. For all categories, a plot of the average of the ratings against the corrected ratings indicates a trend of the time study engineers to rate too low at the higher values and too high at the lower values.

2. The line best fitted, by mathematical means, to all points for the entire group, suggest the trend of this group, on the average, to be outside the +5% level at values below about 93; the +10% level at values below about 75; the -5% level at values greater than 165; the -10% level at values in excess of 220.

3. Area. The Michigan area had a comparatively low degree of accuracy, the analysis-of-variance test showed it to be significant, but since their amount of experience and familiarity with the method of rating a job film was not determined, and the sample was very small, their score is disregarded. Discounting the Michigan category, raters from various areas rated essentially the same. Therefore, the area in which the plant is located appears to have little or no relationship to accuracy.

4. Experience. Groups with 6 months or more experience rated about the same but with greater accuracy than those with less experience. Those in the 2-4 years category were

EXPERIMENTAL

An analysis of the records of a group of typical time study engineers, when testing job times of various pieces, leads to the following conclusions:

1. For all categories, a plot of the average of the ratings against the corrected ratings indicated a trend at the time study engineers to rate too low at the higher values and too high at the lower values.

2. The line best fitted, by mathematical means, to all points for the entire group, support the trend of this group, on the average, to be outside the +5% level at values below about 65; the +10% level at values below about 75; the -5% level at values greater than 105; the -10% level at values in excess of 130.

3. Area. The Michigan area had a comparatively low degree of accuracy, the analysis-of-variance test showed it to be significant, but since their amount of experience and familiarity with the method of rating a job time was not determined, and the people were very small, their scores in this category. On comparing the Michigan category, tests from various areas rated essentially the same. Therefore, the area in which the plant is located appears to have little or no relationship to accuracy.

4. Experience. Groups with 8 months or more experience rated about the same but with greater accuracy than those with less experience. Those in the 3-4 year category were

slightly higher than the rest. The analysis-of-variance test failed to indicate that the low score of the 0-6 months group was significant, but in view of the irregularity of their accuracy, as indicated by inspection of Table 7a, it is suggested that in general at least 6 months experience is required to make the qualified time study engineer but that accuracy then remains about the same with increased experience.

5. Education. The accuracy of the raters at the $\pm 5\%$ level is practically equal. The 1% difference in their accuracy is not significant. However, at the $\pm 10\%$ level those raters receiving their initial time study training from a company show a significantly, by analysis-of-variance test, greater accuracy. This suggests, at least for this group, at the higher level of accuracy, initial source of time study training does not affect accuracy. At a less rigid degree of accuracy, time study men receiving initial time study training from the company are more accurate than those receiving it from a school. This may not be true of those receiving modern training from either school or company.

6. Concept of Standard Performance. Raters using a film or some other embodiment of standard performance as common practice were superior to those using their own concept despite the fact that no film aid was used in this phase. The difference in accuracy was not significant at the $\pm 5\%$ level of accuracy but was definitely significant at the $\pm 10\%$ level.

slightly higher than the rest. The analysis-of-variance test failed to indicate that the low score of the 2-8 month group was significant, but in view of the irregularity of their accuracy, as indicated by inspection of Table 7, it is suggested that in general at least 8 months experience is required to make the qualified time study engineer not that accuracy then remains about the same with increased experience.

5. Education. The accuracy of the raters at the $\pm 5\%$ level is practically equal. The $\pm 10\%$ difference in their accuracy is not significant. However, at the $\pm 15\%$ level those raters receiving their initial time study training from a company show a significantly, by analysis-of-variance test, greater accuracy. This suggests, at least for this group, at the higher level of accuracy, initial source of time study training does not affect accuracy. At a less rigid degree of accuracy, time study men receiving initial time study training from the company are more accurate than those receiving it from a school. This may not be true of those receiving modern training from either school or company.

6. Concept of Standard Performance. Raters using a film or some other embodiment of standard performance as common practice were superior to those using their own concept. Despite the fact that no film aid was used in this phase. The difference in accuracy was not significant at the $\pm 5\%$ level of accuracy but was definitely significant at the $\pm 10\%$ level.

It is therefore suggested that raters should use a film or some other embodiment of "standard performance", and this reinforces the last statement of conclusion 5.

7. Number of Employees. By inspection the raters in plants employing less than 101 men rated a little lower than those in larger plants. However, this difference is not significant. Therefore the size of plant as reflected in number of plant employees apparently has no effect on raters accuracy.

8. Size of city in which plant is located. Inspection reveals a wide difference in accuracy between a city of less than 5,000 people and a city of 5,000-10,000 people; the analysis-of-variance tests reveals this difference to be insignificant at the $\pm 5\%$ level of accuracy and barely significant at the $\pm 10\%$ level. It is therefore suggested that size of city, in which the plant is located, does not affect raters accuracy significantly.

9. Consistency followed by the same direction as accuracy in all cases. It was, however, slightly higher. This was to be expected from the method in which the data were handled.

10. This analysis suggests that when rating a job film we can probably expect time study engineers in terms of the percentage of personnel within limits indicated, to perform with the following degrees of accuracy:

$\pm 5\%$ level: more than one third----38%.

$\pm 7\frac{1}{2}\%$ level: almost one half-----48%.

It is therefore suggested that future studies use a time or some other embodiment of statistical techniques, and this reflects the last statement of conclusion 6.

7. Number of Employees. By inspection the tests in

plants employed less than 101 men tested a little lower than those in larger plants. However, this difference is not significant. Therefore the size of plant as reflected in number of plant employees apparently has no effect on test accuracy.

8. Size of city in which plant is located. Inspection

reveals a wide difference in accuracy between a city of less than 5,000 people and a city of 5,000-10,000 people; the analysis-of-variance tests reveals this difference to be highly significant at the 1% level of accuracy and barely significant at the 5% level. It is therefore suggested that size of city, in which the plant is located, does not affect test accuracy significantly.

9. Consistency followed by the same direction as accuracy

in all cases. It was, however, slightly higher. This was to be expected from the method in which the data were handled.

10. This analysis suggests that men rating a job high

we can probably expect also high ratings in terms of job performance of personnel within limits indicated, so perform with the following degrees of accuracy:
1% level: more than one third--50%
5% level: almost one half--60%

+10% level: almost two thirds-----62%.

+20% level: the great majority-----86%.

+100 level: almost two thirds-----024.
 +200 level: the great majority-----001.

APPENDIX A

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APPENDIX A

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Table 1a

Breakdown: Tabulation of Numerical Results of all Categories.
 Computed for Accuracy

	$\pm 5\%$		$\pm 7\frac{1}{2}\%$		$\pm 10\%$		$\pm 20\%$	
	No.	%	No.	%	No.	%	No.	%
Overall.	27	38	35	48	45	62	62	86
Northern Mid-West, Less Michigan.	7	37	11	53	12	61	17	85
Central Mid-West.	12	38	17	55	20	65	27	89
Southern Mid-West.	5	42	7	59	9	72	11	88
Michigan.	2	21	3	36	4	45	7	77
Experience, 0-6 mos.	2	33	3	47	4	58	5	78
6 mos.-2 yrs.	7	42	9	53	10	64	14	86
2-4 yrs.	7	39	10	54	13	66	18	93
Over 4 yrs.	11	39	16	53	18	63	26	89
Education. College.	8	36	11	49	13	59	18	81
Company	16	38	24	56	28	66	39	87
Use own Concept of Standard Performance	20	37	28	51	34	62	49	87
Uses film or other embodiment of Standard Performance	7	44	9	61	11	75	15	98

Table 1b

Breakdown: Tabulation of Numerical Results of all Categories.

Computed for Consistency

	$\pm 5\%$		$\pm 7\frac{1}{2}\%$		$\pm 10\%$		$\pm 20\%$	
	No.	%	No.	%	No.	%	No.	%
Overall.	29	40	41	57	50	69	62	86
Northern Mid-West, Less Michigan.	8	39	11	52	13	66	17	86
Central Mid-West.	13	42	18	58	22	73	27	88
Southern Mid-West.	6	51	8	63	9	74	11	88
Michigan.	3	31	3	37	4	48	6	71
Experience, 0-6 mos.	2	35	3	51	4	65	5	82
6 mos.-2 yrs.	6	40	9	57	11	66	14	87
2-4 yrs.	8	39	12	61	13	70	17	91
Over 4 yrs.	13	44	17	58	20	67	26	90
Education. College.	8	38	12	54	14	64	18	82
Company.	19	43	27	60	32	71	40	88
Use own Concept of Standard Performance	20	38	29	53	37	68	47	87
Uses film or other embodiment of Standard Performance.	8	56	11	72	13	84	15	98

Table 1b

Breakdown: Tabulation of Numerical Results of All Categories.

Computed for Consistency

	+54	+71/2	+104	+1504
No.	No.	No.	No.	No.
Overall	38	41	50	58
Northern Mid-West	8	11	13	17
Less Michigan	8	11	13	17
Central Mid-West	13	18	23	27
Southern Mid-West	8	8	7	11
Michigan	8	3	4	5
Experience	2	3	4	5
0-6 mos.	2	3	4	5
6 mos.-1 yr.	8	8	11	14
1-2 yrs.	8	13	13	17
Over 2 yrs.	18	17	20	23
Education	8	13	14	18
College	8	13	14	18
Company	18	27	33	40
Use own concept of	28	33	37	47
Standard Performance	28	33	37	47
Use film or other	8	11	13	15
embodiment of	8	11	13	15
Standard Performance	8	11	13	15

Table 2a

Breakdown: Entire Group.

Number of Raters: 72

Evaluation for accuracy.

Corrected Ratings.	Sequence Shown	<u>+5%</u>		<u>+7½%</u>		<u>+10%</u>		<u>+20%</u>	
		No.	%	No.	%	No.	%	No.	%
155	12	29	47	46	64	48	67	66	92
143	4	23	32	32	44	47	65	67	93
137	11	38	53	46	64	57	79	66	92
132	8	34	47	44	61	50	69	63	87
122	1	31	43	45	65	56	78	67	93
118	5	30	42	45	65	52	72	65	90
105	10	25	34	32	44	42	58	63	87
98	2	31	43	40	55	49	68	64	89
95	6	26	36	32	44	42	58	57	79
92	3	24	33	28	39	35	49	60	83
81	9	17	24	31	29	28	39	53	74
79	7	18	25	26	36	32	44	54	75
Average:		27	38%	35	48%	45	62%	62	86%

Page 3

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NUMBER OF JETS: 11

RECEIVED THE RECORDS.

Reversed Sequence Initials. Shown		+24		+17		+10		+5	
No.	Initials.	No.	Initials.	No.	Initials.	No.	Initials.	No.	Initials.
155	18	32	47	48	64	48	63	32	47
143	4	33	38	38	44	47	62	37	52
134	11	30	23	48	64	37	49	38	53
122	8	24	17	47	61	20	60	32	47
128	1	31	42	42	52	22	78	37	52
118	2	30	43	42	62	23	78	32	47
108	10	25	34	38	44	43	58	37	52
98	3	21	43	40	52	43	68	37	52
92	6	28	38	22	44	43	58	37	52
83	3	24	23	38	20	22	46	30	43
61	8	17	34	31	20	28	5	23	34
72	7	18	25	26	26	23	44	24	32

Table 2b

Breakdown: Entire Group

Number of Raters: 72

Evaluation for consistency.

Average Ratings	Sequence Shown	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
149	12	36	50	44	61	52	72	64	89
135	4	35	49	49	68	62	86	68	95
135	11	36	50	48	67	59	82	66	92
130	8	30	42	45	63	48	67	63	88
121	1	33	46	48	67	58	81	67	93
115	5	33	46	43	60	54	75	66	92
110	10	26	36	42	58	51	71	61	85
102	2	27	37	43	60	48	67	64	89
101	6	28	39	37	51	44	61	58	81
98	3	22	31	41	57	49	68	61	85
86	9	19	26	22	31	31	50	54	75
84	7	20	28	28	39	34	47	50	79
Average:		29	40%	41	57%	50	69%	62	86%

Table 20

Breakdown: Entire Group
 Number of Haters: 78
 Evaluation for consistency.

Average Rating	Deviation Score	15%	17 1/2%	110%	130%
No.	No.	No.	No.	No.	No.
149	13	38	44	53	64
135	4	32	43	63	68
138	11	38	48	59	68
130	8	30	42	48	63
131	1	33	48	58	67
115	5	35	43	60	66
110	10	36	43	58	62
103	3	37	43	60	64
101	6	38	37	51	58
98	3	33	41	57	61
66	8	19	33	31	54
84	7	30	38	34	50
Average:		39	40 1/2	57 1/2	63

Table 3a

Breakdown: Area-Northern Mid-West, less Michigan.

Number of Raters: 20

Evaluation for accuracy.

Corrected Ratings	Sequence Shown	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
152	12	5	25	12	60	12	60	19	95
140	4	8	40	12	60	13	65	18	90
134	11	9	45	12	60	17	85	18	90
129	8	9	45	12	60	14	70	17	85
119	1	16	80	17	85	18	90	20	100
115	5	10	50	14	70	15	75	18	90
102	10	4	20	5	25	7	35	17	85
96	2	7	35	13	65	13	65	19	95
93	6	8	40	9	45	9	45	16	80
90	3	6	30	10	50	11	55	17	85
79	9	4	20	6	30	9	45	13	65
77	7	3	15	6	30	10	50	14	70
Average:		7	37%	11	53%	12	61%	17	85%

Table 2a

Greenhouse: Attn-Northern Mid-West, Iowa Midwestern.

Number of Plants: 20

Evaluation for accuracy.

Rating	Corrected Seedlings	+50				+100				+150			
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
152	13	5	25	13	60	13	60	13	60	13	60	13	60
140	4	2	40	13	60	13	60	13	60	13	60	13	60
134	11	3	45	13	60	13	60	13	60	13	60	13	60
129	8	3	45	13	60	13	60	13	60	13	60	13	60
118	1	10	30	13	60	13	60	13	60	13	60	13	60
115	5	10	50	14	70	13	60	13	60	13	60	13	60
103	10	4	50	5	25	7	35	13	60	13	60	13	60
98	3	7	35	13	60	13	60	13	60	13	60	13	60
83	6	8	40	9	45	9	45	13	60	13	60	13	60
60	3	6	30	10	50	11	55	13	60	13	60	13	60
70	9	4	20	6	30	9	45	13	60	13	60	13	60
77	7	5	15	8	30	10	50	13	60	13	60	13	60
Average:		7	37.5	11	55	13	65	13	65	13	65	13	65

Table 3b

Breakdown: Area-Northern Mid-West, less Michigan.

Number of Raters: 20

Evaluation for consistency.

Average Ratings.	Sequence Shown	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
147	12	6	30	8	40	11	55	19	95
132	4	14	70	16	80	18	90	19	95
134	11	8	40	11	55	13	65	18	90
127	8	8	40	12	60	14	70	17	85
120	1	15	75	16	80	18	90	20	100
113	5	11	55	13	65	15	75	18	90
106	10	4	20	8	40	10	50	17	85
101	2	7	35	11	55	16	80	19	95
100	6	5	25	7	35	14	70	15	75
94	3	9	45	10	50	13	65	18	90
80	9	4	20	7	35	9	45	14	70
79	7	4	20	7	35	9	45	14	70
Average:		8	39%	11	52%	13	66%	17	86%

Table 3b

Breakdown: West-Northern mid-west, less Michigan.

Number of Waters: 20

Evaluation for consistency.

Average Rating.	Consistency Known	±5%		±7½%		±10%		±20%	
		No.	%	No.	%	No.	%	No.	%
147	12	8	30	8	40	11	25	12	65
138	4	14	70	18	80	18	80	18	95
134	11	8	40	11	55	13	65	18	80
137	8	8	40	12	60	14	70	17	65
130	1	12	75	18	80	18	90	20	100
112	5	11	55	13	65	15	75	18	90
108	10	4	30	8	40	10	50	17	85
101	3	7	35	11	55	16	80	19	95
100	6	5	25	7	35	14	70	15	75
94	3	8	45	10	50	13	65	18	90
80	8	4	30	7	35	9	45	14	70
75	7	4	30	7	35	9	45	14	70
Average:		8	30%	11	55%	13	65%	17	85%

Table 4a

Breakdown: Area-Central Mid-West.

Number of Raters: 31

Evaluation for accuracy.

Corrected Ratings	Sequence Shown	$\pm 5\%$		$\pm 7\frac{1}{2}\%$		$\pm 10\%$		$\pm 20\%$	
		No.	%	No.	%	No.	%	No.	%
150	12	19	61	20	65	23	74	30	97
139	4	13	39	17	55	21	68	30	97
133	11	17	55	27	87	26	90	30	97
128	8	13	42	18	58	27	87	29	94
118	1	13	42	23	74	27	87	29	94
114	5	15	48	20	65	25	81	31	100
102	10	8	26	15	48	16	52	25	81
95	2	15	48	19	61	21	68	25	81
93	6	9	29	13	42	14	45	26	84
90	3	8	26	14	45	15	48	26	84
79	9	5	16	9	29	11	36	23	74
76	7	6	19	9	29	14	45	25	81
Average:		12	38%	17	55%	20	65%	27	89%

28. 01. 2002

Brooklyn: First-Hand 1975-1976

12 28746 70 70000

REVISED FOR THE 1980S

Year	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	

Table 4b

Breakdown: Aren-Central Mid-West.

Number of Raters: 31

Evaluation for consistency.

Average Ratings	Sequence Shown	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
143	12	13	42	18	58	27	87	29	94
131	4	14	45	22	71	29	94	31	100
129	11	18	58	24	78	27	87	31	100
126	8	12	39	20	65	26	84	29	94
119	1	13	42	22	71	27	87	29	94
111	5	13	42	20	65	23	74	30	97
107	10	12	39	17	55	24	78	28	91
101	2	13	42	15	48	22	71	24	78
100	6	16	52	18	58	19	61	27	87
95	3	13	42	14	45	19	61	26	84
84	9	10	32	14	45	14	45	22	71
82	7	11	35	12	39	13	42	21	68
Average:		13	42%	18	58%	22	73%	27	88%

Application for Consistency.

Station	Time	Wind	Temp	Bar	Hum	Clouds	Remarks
100	10	10	10	10	10	10	10
98	10	10	10	10	10	10	10
84	10	10	10	10	10	10	10
78	10	10	10	10	10	10	10
101	10	10	10	10	10	10	10
107	10	10	10	10	10	10	10
111	10	10	10	10	10	10	10
118	10	10	10	10	10	10	10
128	10	10	10	10	10	10	10
138	10	10	10	10	10	10	10
131	10	10	10	10	10	10	10
143	10	10	10	10	10	10	10

Table 5a

Breakdown: Area---Southern Mid-West.

Number of Raters: 12

Evaluation for accuracy.

Corrected Ratings	Sequence Shown.	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
165	12	3	25	9	75	10	83	12	100
152	4	4	33	7	58	7	58	12	100
146	11	10	83	10	83	10	83	11	92
140	8	8	67	9	75	10	83	11	92
130	1	3	25	5	42	9	75	12	100
126	5	6	50	6	50	9	75	11	92
112	10	5	42	9	75	9	75	10	83
105	2	2	17	6	50	9	75	10	83
101	6	5	42	8	67	8	67	10	83
99	3	6	50	7	58	9	75	11	92
87	9	2	17	3	25	6	50	9	75
84	7	6	50	6	50	7	58	8	67
Average:		5	42%	7	59%	9	72%	11	88%

2000-0000

[illegible]

51 : 510155 to 150000

At the time of the

Year	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	

Table 5b

Breakdown: Area---Southern Mid-West.

Number of Raters: 12.

Evaluation for consistency.

Average Ratings	Sequence Shown	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
159	12	10	83	10	83	11	92	11	92
144	4	6	50	8	67	11	92	11	92
145	11	10	83	10	83	11	92	11	92
141	8	8	67	9	75	10	83	11	92
125	1	6	50	6	50	7	58	11	92
125	5	6	50	6	50	9	75	10	83
117	10	5	42	7	58	8	67	11	92
106	2	2	17	6	50	7	58	10	83
102	6	5	42	8	67	8	67	10	83
106	3	6	50	9	75	9	75	11	92
96	9	5	42	6	50	8	67	9	75
92	7	4	33	5	42	7	58	10	83
Average:		6	51%	8	63%	9	74%	11	88%

Table 20

STATION: 1911-1912

Number of Observations: 11

Direction of Current: N

Station	Time	Direction	Force	Direction	Force	Direction	Force	Direction	Force
191	10	N	10	N	10	N	10	N	10
192	10	N	10	N	10	N	10	N	10
193	10	N	10	N	10	N	10	N	10
194	10	N	10	N	10	N	10	N	10
195	10	N	10	N	10	N	10	N	10
196	10	N	10	N	10	N	10	N	10
197	10	N	10	N	10	N	10	N	10
198	10	N	10	N	10	N	10	N	10
199	10	N	10	N	10	N	10	N	10
200	10	N	10	N	10	N	10	N	10
201	10	N	10	N	10	N	10	N	10
202	10	N	10	N	10	N	10	N	10
203	10	N	10	N	10	N	10	N	10
204	10	N	10	N	10	N	10	N	10
205	10	N	10	N	10	N	10	N	10
206	10	N	10	N	10	N	10	N	10
207	10	N	10	N	10	N	10	N	10
208	10	N	10	N	10	N	10	N	10
209	10	N	10	N	10	N	10	N	10
210	10	N	10	N	10	N	10	N	10
211	10	N	10	N	10	N	10	N	10
212	10	N	10	N	10	N	10	N	10
213	10	N	10	N	10	N	10	N	10
214	10	N	10	N	10	N	10	N	10
215	10	N	10	N	10	N	10	N	10
216	10	N	10	N	10	N	10	N	10
217	10	N	10	N	10	N	10	N	10
218	10	N	10	N	10	N	10	N	10
219	10	N	10	N	10	N	10	N	10
220	10	N	10	N	10	N	10	N	10
221	10	N	10	N	10	N	10	N	10
222	10	N	10	N	10	N	10	N	10
223	10	N	10	N	10	N	10	N	10
224	10	N	10	N	10	N	10	N	10
225	10	N	10	N	10	N	10	N	10
226	10	N	10	N	10	N	10	N	10
227	10	N	10	N	10	N	10	N	10
228	10	N	10	N	10	N	10	N	10
229	10	N	10	N	10	N	10	N	10
230	10	N	10	N	10	N	10	N	10
231	10	N	10	N	10	N	10	N	10
232	10	N	10	N	10	N	10	N	10
233	10	N	10	N	10	N	10	N	10
234	10	N	10	N	10	N	10	N	10
235	10	N	10	N	10	N	10	N	10
236	10	N	10	N	10	N	10	N	10
237	10	N	10	N	10	N	10	N	10
238	10	N	10	N	10	N	10	N	10
239	10	N	10	N	10	N	10	N	10
240	10	N	10	N	10	N	10	N	10
241	10	N	10	N	10	N	10	N	10
242	10	N	10	N	10	N	10	N	10
243	10	N	10	N	10	N	10	N	10
244	10	N	10	N	10	N	10	N	10
245	10	N	10	N	10	N	10	N	10
246	10	N	10	N	10	N	10	N	10
247	10	N	10	N	10	N	10	N	10
248	10	N	10	N	10	N	10	N	10
249	10	N	10	N	10	N	10	N	10
250	10	N	10	N	10	N	10	N	10
251	10	N	10	N	10	N	10	N	10
252	10	N	10	N	10	N	10	N	10
253	10	N	10	N	10	N	10	N	10
254	10	N	10	N	10	N	10	N	10
255	10	N	10	N	10	N	10	N	10
256	10	N	10	N	10	N	10	N	10
257	10	N	10	N	10	N	10	N	10
258	10	N	10	N	10	N	10	N	10
259	10	N	10	N	10	N	10	N	10
260	10	N	10	N	10	N	10	N	10
261	10	N	10	N	10	N	10	N	10
262	10	N	10	N	10	N	10	N	10
263	10	N	10	N	10	N	10	N	10
264	10	N	10	N	10	N	10	N	10
265	10	N	10	N	10	N	10	N	10
266	10	N	10	N	10	N	10	N	10
267	10	N	10	N	10	N	10	N	10
268	10	N	10	N	10	N	10	N	10
269	10	N	10	N	10	N	10	N	10
270	10	N	10	N	10	N	10	N	10
271	10	N	10	N	10	N	10	N	10
272	10	N	10	N	10	N	10	N	10
273	10	N	10	N	10	N	10	N	10
274	10	N	10	N	10	N	10	N	10
275	10	N	10	N	10	N	10	N	10
276	10	N	10	N	10	N	10	N	10
277	10	N	10	N	10	N	10	N	10
278	10	N	10	N	10	N	10	N	10
279	10	N	10	N	10	N	10	N	10
280	10	N	10	N	10	N	10	N	10
281	10	N	10	N	10	N	10	N	10
282	10	N	10	N	10	N	10	N	10
283	10	N	10	N	10	N	10	N	10
284	10	N	10	N	10	N	10	N	10
285	10	N	10	N	10	N	10	N	10
286	10	N	10	N	10	N	10	N	10
287	10	N	10	N	10	N	10	N	10
288	10	N	10	N	10	N	10	N	10
289	10	N	10	N	10	N	10	N	10
290	10	N	10	N	10	N	10	N	10
291	10	N	10	N	10	N	10	N	10
292	10	N	10	N	10	N	10	N	10
293	10	N	10	N	10	N	10	N	10
294	10	N	10	N	10	N	10	N	10
295	10	N	10	N	10	N	10	N	10
296	10	N	10	N	10	N	10	N	10
297	10	N	10	N	10	N	10	N	10
298	10	N	10	N	10	N	10	N	10
299	10	N	10	N	10	N	10	N	10
300	10	N	10	N	10	N	10	N	10

Table 6a

Breakdown: Area---Michigan.

Number of Raters: 9

Evaluation for accuracy.

Corrected Ratings	Sequence Shown	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
165	13	1	11	3	33	4	44	9	100
153	4	1	11	2	22	2	22	8	88
145	11	2	22	4	44	5	55	8	88
140	8	1	11	2	22	3	33	7	77
130	1	1	11	2	22	2	22	5	55
125	5	2	22	4	44	4	44	6	66
111	10	3	33	6	66	6	66	6	66
104	2	1	11	3	33	4	44	7	77
101	6	4	44	4	44	5	55	7	77
98	3	4	44	4	44	4	44	7	77
86	9	2	22	2	22	6	66	7	77
84	7	1	11	3	33	4	44	6	66
Average:		2	21%	3	36%	4	45%	7	77%

Department of Agriculture, Bureau of Entomology and Plant Quarantine

Number of insects: 5

Material for analysis

No.	Sex	Age	Length	Wing	Tail	Tarsus	Culmen	Gape	Weight	Notes
100	♂	1	11	11	11	11	11	11	11	
101	♂	1	11	11	11	11	11	11	11	
102	♂	1	11	11	11	11	11	11	11	
103	♂	1	11	11	11	11	11	11	11	
104	♂	1	11	11	11	11	11	11	11	
105	♂	1	11	11	11	11	11	11	11	
106	♂	1	11	11	11	11	11	11	11	
107	♂	1	11	11	11	11	11	11	11	
108	♂	1	11	11	11	11	11	11	11	
109	♂	1	11	11	11	11	11	11	11	
110	♂	1	11	11	11	11	11	11	11	
111	♂	1	11	11	11	11	11	11	11	
112	♂	1	11	11	11	11	11	11	11	
113	♂	1	11	11	11	11	11	11	11	
114	♂	1	11	11	11	11	11	11	11	
115	♂	1	11	11	11	11	11	11	11	
116	♂	1	11	11	11	11	11	11	11	
117	♂	1	11	11	11	11	11	11	11	
118	♂	1	11	11	11	11	11	11	11	
119	♂	1	11	11	11	11	11	11	11	
120	♂	1	11	11	11	11	11	11	11	
121	♂	1	11	11	11	11	11	11	11	
122	♂	1	11	11	11	11	11	11	11	
123	♂	1	11	11	11	11	11	11	11	
124	♂	1	11	11	11	11	11	11	11	
125	♂	1	11	11	11	11	11	11	11	
126	♂	1	11	11	11	11	11	11	11	
127	♂	1	11	11	11	11	11	11	11	
128	♂	1	11	11	11	11	11	11	11	
129	♂	1	11	11	11	11	11	11	11	
130	♂	1	11	11	11	11	11	11	11	
131	♂	1	11	11	11	11	11	11	11	
132	♂	1	11	11	11	11	11	11	11	
133	♂	1	11	11	11	11	11	11	11	
134	♂	1	11	11	11	11	11	11	11	
135	♂	1	11	11	11	11	11	11	11	
136	♂	1	11	11	11	11	11	11	11	
137	♂	1	11	11	11	11	11	11	11	
138	♂	1	11	11	11	11	11	11	11	
139	♂	1	11	11	11	11	11	11	11	
140	♂	1	11	11	11	11	11	11	11	
141	♂	1	11	11	11	11	11	11	11	
142	♂	1	11	11	11	11	11	11	11	
143	♂	1	11	11	11	11	11	11	11	
144	♂	1	11	11	11	11	11	11	11	
145	♂	1	11	11	11	11	11	11	11	
146	♂	1	11	11	11	11	11	11	11	
147	♂	1	11	11	11	11	11	11	11	
148	♂	1	11	11	11	11	11	11	11	
149	♂	1	11	11	11	11	11	11	11	
150	♂	1	11	11	11	11	11	11	11	

Table 6b

Breakdown: Area---Michigan.

Number of Raters: 9.

Evaluation for consistency.

Average Ratings	Sequence Shown	$\pm 5\%$		$\pm 7\frac{1}{2}\%$		$\pm 10\%$		$\pm 20\%$	
		No.	%	No.	%	No.	%	No.	%
158	12	4	44	5	55	6	66	8	88
145	4	2	22	3	33	6	66	7	77
144	11	3	33	4	44	5	55	7	77
134	8	3	33	4	44	4	44	7	77
123	1	2	22	2	22	4	44	6	66
123	5	4	44	4	44	4	44	6	66
116	10	3	33	4	44	5	55	6	66
107	2	1	11	2	22	3	33	7	77
107	6	3	33	3	33	4	44	6	66
111	3	2	22	3	33	3	33	6	66
98	9	3	33	3	33	5	55	6	66
92	7	3	33	3	33	3	33	5	55
Average:		3	31%	3	37%	4	48%	6	71%

Table 6b

Stratified: Area--Michigan.

Number of Areas: 8.

Evaluation for consistency.

Rating	Sequence	±2σ	±1½σ	±1σ	±1/2σ
No.	No.	No.	No.	No.	No.
158	18	4	44	2	22
145	4	2	33	2	23
144	11	3	33	4	44
134	8	3	33	4	44
133	1	2	33	2	23
132	2	4	44	4	44
116	10	3	33	4	44
107	2	1	11	2	23
107	8	2	23	2	23
111	2	2	33	2	23
88	8	2	33	2	23
22	7	2	33	2	23
Average:		3	31½	3	27½

Table 7a

Breakdown: Experience---0-6 Months.

Number of Raters: 6

Evaluation for accuracy.

Corrected Ratings	Sequence Shown	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
152	12	4	67	4	67	4	67	6	100
140	4	3	50	4	67	4	67	6	100
134	11	3	50	4	67	5	83	6	100
129	8	2	33	3	50	5	83	5	83
120	1	4	67	4	67	5	83	6	100
116	5	3	50	4	67	4	67	5	83
103	10	1	17	2	33	3	50	5	83
96	2	3	50	3	50	4	67	5	83
93	6	0	0	1	17	2	33	4	67
91	3	0	0	2	33	3	50	3	50
80	9	1	17	1	17	1	17	3	50
77	7	0	0	2	33	2	33	2	33
Average:		2	33%	3	47%	4	58%	5	78%

Table 7a

Breakdown: Experience--0-8 Months.

Number of Haters: 8

Evaluation for accuracy.

Rating	Corrected Response	±5%		±7½%		±10%		±13%	
		No.	%	No.	%	No.	%	No.	%
123	15	4	67	4	67	4	67	6	100
140	4	3	50	4	67	4	67	6	100
134	11	3	50	4	67	5	83	6	100
128	8	3	33	3	50	3	50	5	83
130	1	4	67	4	67	5	83	6	100
118	5	3	50	4	67	4	67	5	83
100	10	1	17	3	33	3	50	5	83
88	3	3	50	3	50	4	67	5	83
95	6	0	0	1	17	3	33	4	67
91	3	0	0	3	33	3	50	3	50
80	3	1	17	1	17	1	17	3	50
77	7	0	0	3	33	3	50	3	50
Average:		3	33	3	47	4	58	5	76

Table 7b

Breakdown: Experience---0-6 Months.

Number of Raters: 6.

Evaluation for consistency.

Average Ratings	Sequence Shown	$\pm 5\%$		$\pm 7\frac{1}{2}\%$		$\pm 10\%$		$\pm 20\%$	
		No.	%	No.	%	No.	%	No.	%
145	12	2	33	4	67	6	100	6	100
132	4	2	33	4	67	6	100	6	100
131	11	1	17	4	67	5	83	6	100
129	8	2	33	3	50	5	83	5	83
122	1	3	50	4	67	5	83	6	100
110	5	2	33	2	33	2	33	4	67
108	10	3	50	3	50	3	50	5	83
103	2	4	67	4	67	4	67	5	83
96	6	1	17	2	33	4	67	4	67
95	3	3	50	3	50	3	50	4	67
84	9	0	0	2	33	2	33	4	67
83	7	2	33	2	33	2	33	4	67
Average:		2	35%	3	51%	4	65%	5	82%

Table 7b

Frequency: 0-6 months.

Number of letters: 6.

Evaluation for consistency.

Letter	Average	Deviation	±2σ		±1σ		±1σ		±2σ	
			No.	%	No.	%	No.	%	No.	%
65	3	3	3	33	3	33	3	33	4	67
66	0	0	0	0	3	33	3	33	3	50
67	3	3	3	30	3	30	3	30	4	67
68	6	1	1	17	3	33	4	67	4	67
69	3	3	3	30	3	30	3	30	4	67
70	3	3	3	30	3	30	3	30	4	67
71	5	2	3	33	3	33	3	33	4	67
72	10	3	3	30	3	30	3	30	5	83
73	3	4	4	67	4	67	4	67	5	83
74	0	0	0	0	3	33	3	33	4	67
75	3	3	3	30	3	30	3	30	4	67
76	6	1	1	17	3	33	4	67	4	67
77	3	3	4	67	4	67	4	67	5	83
78	10	3	3	30	3	30	3	30	5	83
79	5	2	3	33	3	33	3	33	4	67
80	3	3	3	30	3	30	3	30	4	67
81	3	3	3	30	3	30	3	30	4	67
82	3	3	3	30	3	30	3	30	4	67
83	3	3	3	30	3	30	3	30	4	67
84	3	3	3	30	3	30	3	30	4	67
85	3	3	3	30	3	30	3	30	4	67
86	3	3	3	30	3	30	3	30	4	67
87	3	3	3	30	3	30	3	30	4	67
88	3	3	3	30	3	30	3	30	4	67
89	3	3	3	30	3	30	3	30	4	67
90	3	3	3	30	3	30	3	30	4	67
91	3	3	3	30	3	30	3	30	4	67
92	3	3	3	30	3	30	3	30	4	67
93	3	3	3	30	3	30	3	30	4	67
94	3	3	3	30	3	30	3	30	4	67
95	3	3	3	30	3	30	3	30	4	67
96	3	3	3	30	3	30	3	30	4	67
97	3	3	3	30	3	30	3	30	4	67
98	3	3	3	30	3	30	3	30	4	67
99	3	3	3	30	3	30	3	30	4	67
100	3	3	3	30	3	30	3	30	4	67

Table 8a

Breakdown: Experience---6 Months to 2 Years.

Number of Raters: 16

Evaluation for accuracy.

Corrected Ratings	Sequence Shown	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
156	12	8	50	9	56	12	75	16	100
144	4	6	37	9	56	11	69	14	88
138	11	5	31	9	56	11	69	14	88
133	8	8	50	10	63	11	69	14	88
123	1	8	50	9	56	10	63	15	94
119	5	8	50	9	56	12	75	15	94
106	10	8	50	10	63	12	75	14	88
99	2	9	56	11	69	13	81	14	88
96	6	6	37	7	44	9	56	12	75
93	3	7	44	9	56	9	56	15	94
82	9	5	31	6	37	6	37	11	69
80	7	2	13	4	25	7	44	11	69
Average:		7	42½	9	53½	10	64½	14	86½

Table 6a

Program: Experience---6 Months to 3 Years.

Number of Cases: 18

Estimation for Accuracy.

Corrected Average	Corrected Standard Deviation	No.	±1σ	No.	±1σ	No.	±1σ	No.	±1σ
100	13	8	50	8	50	13	75	18	100
144	4	8	27	8	28	11	83	14	88
128	11	5	31	9	28	11	88	14	88
123	8	8	50	10	68	11	88	14	88
122	1	8	50	9	68	10	83	15	94
119	5	8	50	9	28	13	75	18	94
106	10	8	50	10	63	13	75	14	88
99	3	9	34	11	28	13	81	14	88
97	6	6	37	7	44	9	86	13	75
87	3	7	44	8	28	9	86	15	94
83	9	5	31	5	37	6	37	11	68
69	7	3	13	4	25	7	44	11	68
Average:		7	43	8	33	10	84	14	98

Table 8b

Breakdown: Experience---6 Months to 2 Years.

Number of Raters: 16

Evaluation for consistency.

Average Ratings	Sequence Shown.	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
153	12	6	38	11	69	12	75	15	94
136	4	9	56	11	69	14	88	15	94
136	11	5	31	8	50	12	75	14	88
130	8	6	38	10	63	10	63	14	88
122	1	8	50	9	56	12	75	15	94
116	5	7	44	11	69	12	75	15	94
107	10	8	50	11	69	12	75	14	88
105	2	9	56	10	63	12	75	15	94
105	6	5	31	7	44	8	50	13	81
102	3	8	50	11	69	11	69	15	94
84	9	4	25	6	38	6	38	11	69
83	7	2	13	5	31	6	38	11	69
Average:		6	40%	9	57%	11	66%	14	87%

Table 32

Readings: Experimental—5 hours to 2 years.
Number of tests: 15
Evaluation for consistency.

Average Range		Average Range		Average Range		Average Range		Average Range		Average Range	
No.	±10%	No.	±10%	No.	±10%	No.	±10%	No.	±10%	No.	±10%
152	12	8	38	11	63	18	75	15	84	15	84
151	4	9	38	11	68	14	68	13	64	13	64
150	11	5	31	8	50	18	78	14	68	14	68
130	8	8	38	10	63	10	63	14	68	14	68
129	1	8	30	9	58	13	75	13	64	13	64
119	5	7	44	11	68	13	75	15	84	15	84
107	10	8	30	11	68	18	78	14	68	14	68
106	3	9	33	10	65	13	75	15	84	15	84
105	6	5	31	7	44	8	50	13	61	13	61
103	7	8	33	11	68	11	68	15	84	15	84
84	8	4	35	8	38	8	38	11	68	11	68
83	7	5	18	5	31	9	38	11	68	11	68
Average:		8	40	9	52	11	68	14	84	14	84

Table 9a

Breakdown: Experience---2 To 4 Years.

Number of Raters: 19.

Evaluation for accuracy.

Corrected Sequence Ratings Shown	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
	No.	%	No.	%	No.	%	No.	%
155 12	9	47	14	74	14	74	19	100
143 4	5	26	11	58	16	84	19	100
137 11	10	53	11	58	17	90	19	100
132 8	12	63	15	79	15	79	19	100
122 1	9	47	14	74	16	84	19	100
118 5	9	47	13	69	14	74	19	100
105 10	6	32	8	42	12	63	18	95
98 2	8	42	10	53	12	63	18	95
95 6	6	32	9	47	11	58	16	84
92 3	7	37	8	42	10	53	17	90
81 9	4	21	6	32	8	42	13	69
79 7	3	16	4	21	6	32	15	79
Average:	7	39%	10	54%	13	66%	18	93%

Table 6
Breakdown: Experience--2 To 4 Years.
Number of Papers: 19.
Evaluation for accuracy.

Corrected Sequence Rating	Corrected Sequence	±10%	±15%	±10%	±20%
No.	No.	No.	No.	No.	No.
155	13	9	14	14	18
143	4	5	11	18	19
137	11	10	11	17	19
135	8	13	15	15	18
133	1	9	14	16	19
116	5	8	13	14	19
105	10	8	8	15	18
98	3	8	10	13	18
95	6	6	9	11	18
92	3	7	8	10	17
81	9	4	6	8	13
78	7	3	4	6	15
Average:	7	7	10	13	18

Table 9b

Breakdown: Experience---2 To 4 Years.

Number of Raters: 19.

Evaluation for consistency.

Average Ratings	Sequence Shown	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
147	12	7	37	13	68	16	84	19	100
135	4	10	53	15	79	18	95	19	100
134	11	9	47	13	63	16	84	19	100
131	8	12	63	15	79	15	79	19	100
121	1	9	47	15	79	16	84	19	100
116	5	11	58	13	68	15	79	18	95
111	10	9	47	13	68	15	79	18	95
103	2	3	16	8	42	10	53	18	95
102	6	7	37	9	47	9	47	15	79
98	3	4	21	12	63	13	68	18	95
83	9	5	26	8	42	8	42	13	68
84	7	4	21	6	32	9	47	12	63
Average:		8	39%	12	61%	13	70%	17	91%

Table 20

Breakdown: Experience---2 to 4 Years.

Number of Entries: 18.

Fluctuation for consistency.

Ratio	Sequence	+5	+7	+10	+30
No.	No.	No.	No.	No.	No.
147	13	87	13	88	18 100
138	4	53	15	78	18 100
134	11	47	13	83	16 100
131	8	63	18	73	13 100
131	1	47	15	73	16 100
118	5	58	13	68	15 85
111	10	47	13	68	15 85
103	3	16	8	43	10 85
102	2	37	9	47	15 75
98	3	31	13	63	13 85
93	2	32	8	43	9 88
84	7	31	6	33	9 85
8	8	33	13	61	13 75

Table 10a

Breakdown: Experience---Over 4 Years.

Number of Raters: 29.

Evaluation for accuracy.

Corrected Ratings	Sequence Shown	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
151	12	14	48	18	62	21	73	27	93
140	4	9	31	16	55	19	66	27	93
133	11	20	69	25	86	25	86	27	93
128	8	10	35	15	42	22	76	26	90
119	1	14	48	20	69	25	86	26	90
115	5	13	45	17	59	23	83	27	93
102	10	8	28	12	41	13	45	26	90
96	2	13	45	16	55	19	66	27	93
92	6	11	37	13	45	14	48	27	93
90	3	8	28	12	41	14	48	25	86
79	9	5	17	7	24	8	28	21	73
77	7	9	31	15	52	17	59	23	79
Average:		11	39%	16	53%	18	63%	26	89%

Table 10a

STATIONARY EXPERIMENT—OVER 4 YEARS.

Number of Plants: 20.

Station for recovery.

Station		Corrected Standard Deviation		+2s		+1s		-1s		-2s	
No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
151	13	14	48	18	68	21	75	27	23	27	23
146	4	8	21	10	28	12	44	27	24	27	24
133	11	20	68	22	58	22	68	27	24	27	24
128	8	10	28	12	48	22	78	28	24	28	24
118	1	12	48	20	68	22	68	28	24	28	24
113	8	13	48	14	28	22	68	27	24	27	24
103	10	8	28	12	41	13	42	28	24	28	24
98	3	12	42	16	62	19	68	27	24	27	24
93	6	11	27	12	42	14	48	27	24	27	24
88	3	8	28	12	41	14	48	22	24	22	24
78	8	2	17	7	24	8	28	27	24	27	24
72	2	8	27	12	28	12	28	27	24	27	24
11	11	204	16	224	18	234	28	244	28	244	28

Table 10b

Breakdown: Experience---Over 4 Years.

Number of Raters: 29

Evaluation for consistency.

Average Ratings	Sequence Shown	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
145	12	13	45	20	69	23	79	27	93
132	4	16	55	22	76	24	83	28	97
133	11	20	69	25	86	25	86	27	93
126	8	13	45	18	62	19	66	26	90
117	1	16	55	22	76	22	76	28	97
112	5	11	38	18	62	21	73	27	93
108	10	9	31	13	45	19	66	25	86
99	2	11	38	13	45	19	66	27	93
97	6	11	38	17	59	19	66	27	93
95	3	10	35	13	45	18	62	26	90
87	9	10	35	11	38	14	48	23	79
82	7	14	48	14	48	14	48	22	76
Average:		13	44%	17	59%	20	67%	26	90%

RECEIVED
JAN 10 1964

05 : 07:30 To 12:00

STATION FOR RECEIVING.

[illegible]

Table 11a

Breakdown: Education---Initial Time Study Training Received
In College.

Number of Raters: 22.

Evaluation for accuracy.

Corrected Ratings	Sequence Shown	$\pm 5\%$		$\pm 7\frac{1}{2}\%$		$\pm 10\%$		$\pm 20\%$	
		No.	%	No.	%	No.	%	No.	%
156	12	13	59	15	68	17	77	19	87
144	4	8	36	13	59	16	73	20	91
138	11	9	41	12	55	15	68	18	82
133	8	9	41	12	55	14	64	17	77
123	1	10	46	15	68	15	68	20	91
119	5	11	50	13	59	14	64	19	87
106	10	9	41	11	50	13	59	18	82
99	2	8	36	11	50	14	64	20	91
96	6	7	32	7	32	11	50	16	73
93	3	6	27	7	32	7	32	18	82
82	9	2	9	5	23	5	23	15	68
80	7	5	23	8	36	9	41	14	64
Average:		8	37%	11	49%	13	58%	18	81%

Table 11

Standard: 2000--Initial Time Study Training Received in College.

Number of Averages: 25.

Regression for Accuracy.

Averages	Corrected Average		Distance		100		110		120		130	
	No.	Time	No.	Time	No.	Time	No.	Time	No.	Time	No.	Time
100	2	23	8	38	0	41	14	64				
95	3	24	4	39	2	42	15	65				
90	5	25	7	40	5	43	16	66				
85	8	26	10	41	8	44	17	67				
80	11	27	13	42	11	45	18	68				
75	14	28	16	43	14	46	19	69				
70	17	29	19	44	17	47	20	70				
65	20	30	22	45	20	48	22	71				
60	23	31	25	46	23	49	25	72				
55	26	32	28	47	26	50	28	73				
50	29	33	31	48	29	51	31	74				
45	32	34	34	49	32	52	34	75				
40	35	35	37	50	35	53	37	76				
35	38	36	40	51	38	54	40	77				
30	41	37	43	52	41	55	43	78				
25	44	38	46	53	44	56	46	79				
20	47	39	49	54	47	57	49	80				
15	50	40	52	55	50	58	52	81				
10	53	41	55	56	53	59	55	82				
5	56	42	58	57	56	60	58	83				
0	59	43	61	58	59	61	61	84				
	62	44	64	59	62	62	64	85				
	65	45	67	60	65	63	67	86				
	68	46	70	61	68	64	70	87				
	71	47	73	62	71	65	73	88				
	74	48	76	63	74	66	76	89				
	77	49	79	64	77	67	79	90				
	80	50	82	65	80	68	82	91				
	83	51	85	66	83	69	85	92				
	86	52	88	67	86	70	88	93				
	89	53	91	68	89	71	91	94				
	92	54	94	69	92	72	94	95				
	95	55	97	70	95	73	97	96				
	98	56	100	71	98	74	100	97				
	101	57		72	101	75		98				
	104	58		73	104	76		99				
	107	59		74	107	77		100				
	110	60		75	110	78		101				
	113	61		76	113	79		102				
	116	62		77	116	80		103				
	119	63		78	119	81		104				
	122	64		79	122	82		105				
	125	65		80	125	83		106				
	128	66		81	128	84		107				
	131	67		82	131	85		108				
	134	68		83	134	86		109				
	137	69		84	137	87		110				
	140	70		85	140	88		111				
	143	71		86	143	89		112				
	146	72		87	146	90		113				
	149	73		88	149	91		114				
	152	74		89	152	92		115				
	155	75		90	155	93		116				
	158	76		91	158	94		117				
	161	77		92	161	95		118				
	164	78		93	164	96		119				
	167	79		94	167	97		120				
	170	80		95	170	98		121				
	173	81		96	173	99		122				
	176	82		97	176	100		123				
	179	83		98	179	101		124				
	182	84		99	182	102		125				
	185	85		100	185	103		126				
	188	86		101	188	104		127				
	191	87		102	191	105		128				
	194	88		103	194	106		129				
	197	89		104	197	107		130				
	200	90		105	200	108		131				
	203	91		106	203	109		132				
	206	92		107	206	110		133				
	209	93		108	209	111		134				
	212	94		109	212	112		135				
	215	95		110	215	113		136				
	218	96		111	218	114		137				
	221	97		112	221	115		138				
	224	98		113	224	116		139				
	227	99		114	227	117		140				
	230	100		115	230	118		141				
	233	101		116	233	119		142				
	236	102		117	236	120		143				
	239	103		118	239	121		144				
	242	104		119	242	122		145				
	245	105		120	245	123		146				
	248	106		121	248	124		147				
	251	107		122	251	125		148				
	254	108		123	254	126		149				
	257	109		124	257	127		150				
	260	110		125	260	128		151				
	263	111		126	263	129		152				
	266	112		127	266	130		153				
	269	113		128	269	131		154				
	272	114		129	272	132		155				
	275	115		130	275	133		156				
	278	116		131	278	134		157				
	281	117		132	281	135		158				
	284	118		133	284	136		159				
	287	119		134	287	137		160				
	290	120		135	290	138		161				
	293	121		136	293	139		162				
	296	122		137	296	140		163				
	299	123		138	299	141		164				
	302	124		139	302	142		165				
	305	125		140	305	143		166				
	308	126		141	308	144		167				
	311	127		142	311	145		168				
	314	128		143	314	146		169				
	317	129		144	317	147		170				
	320	130		145	320	148		171				
	323	131		146	323	149		172				
	326	132		147	326	150		173				
	329	133		148	329	151		174				
	332	134		149	332	152		175				
	335	135		150	335	153		176				
	338	136		151	338	154		177				
	341	137		152	341	155		178				
	344	138		153	344	156		179				
	347	139		154	347	157		180				
	350	140		155	350	158		181				
	353	141		156	353	159		182				
	356	142		157	356	160		183				
	359	143		158	359	161		184				
	362	144		159	362	162		185				
	365	145		160	365	163		186				
	368	146		161	368	164		187				
	371	147		162	371	165		188				
	374	148		163	374	166		189				
	377	149		164	377	167		190				
	380	150		165	380	168		191				
	383	151		166	383	169		192				
	386	152		167	386	170		193				
	389	153		168	389	171		194				
	392	154		169	392	172		195				
	395	155		170	395	173		196				
	398	156		171	398	174		197				
	401	157		172	401	175		198				
	404	158		173	404	176		199				
	407	159		174	407	177		200				
	410	160		175	410	178		201				
	413	161		176	413	179		202				
	416	162		177	416	180		203				
	419											

Table 11b

Breakdown: Education---Initial Time Study Training Received
In College.

Number of Raters: 23

Evaluation for consistency.

Average Ratings	Sequence Shown	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
155	12	11	50	16	73	17	77	19	86
138	4	13	55	15	68	15	68	19	86
138	11	9	41	13	55	15	68	19	86
131	8	5	23	11	50	13	59	17	77
121	1	10	46	15	68	17	77	20	91
112	5	7	32	13	59	13	59	20	91
110	10	12	55	13	59	16	73	18	83
102	2	5	23	13	55	15	68	20	91
101	6	7	32	10	46	13	55	16	73
99	3	10	46	11	50	15	68	17	77
87	9	4	18	6	27	11	50	16	73
82	7	7	32	8	36	11	50	16	73
Average:		8	38%	12	54%	14	64%	18	82%

2015 11

Blackboard: Question - Initial Time Study Training received
In College.

U.S. DEPARTMENT OF THE ARMY

Very truly yours,

Latitude	Longitude	No.	Time	No.	Time	No.	Time	No.	Time
85	7	35	8	36	11	20	16	73	
87	8	4	18	6	37	11	20	73	
89	8	10	48	11	20	12	60	77	
101	6	7	33	10	48	13	55	78	
103	8	5	33	13	55	15	58	81	
110	10	13	55	17	59	18	72	83	
115	5	7	33	13	59	13	59	84	
121	1	10	46	15	68	17	77	87	
127	8	5	33	11	50	13	59	88	
136	11	8	41	15	52	15	58	89	
138	4	13	55	15	63	16	58	90	
152	13	11	50	16	73	17	77	96	

Table 12a

Breakdown: Education---Initial Time Study Training Received
With the Company.

Number of Raters: 45.

Evaluation for accuracy.

Corrected Ratings	Sequence Shown	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
153	12	22	49	30	67	32	71	43	95
141	4	17	38	29	64	31	69	42	93
135	11	25	55	35	78	41	91	42	93
130	8	25	56	32	71	39	87	42	93
121	1	20	44	31	69	37	82	43	95
117	5	18	40	30	67	31	69	42	93
104	10	12	27	20	44	26	58	40	89
97	2	19	42	24	53	31	69	40	89
94	6	14	31	19	42	21	47	36	80
91	3	14	31	22	49	25	55	36	80
80	9	12	27	14	31	19	42	30	67
78	7	7	16	17	38	21	47	34	75
Average:		16	38%	24	56%	38	66%	39	87%

Table 13a

Breakdown: Education--Initial Time Study Training Received
With the Company.

Number of Rates: 45.

Evaluation for Agency.

Corrected Sequence		Rating		No.		No.		No.		No.	
Rating		No.		No.		No.		No.		No.	
152	12	52	49	30	27	32	31	41	42	32	31
141	1	17	36	36	64	31	69	42	42	32	31
138	11	32	52	32	76	41	91	42	42	32	31
130	8	32	52	32	71	39	87	42	42	32	31
121	1	30	44	31	69	37	82	42	42	32	31
117	5	18	40	30	67	31	69	42	42	32	31
104	10	12	37	20	44	32	38	40	40	32	31
97	3	13	43	34	52	31	69	40	40	32	31
84	6	14	31	19	42	31	47	32	32	32	31
81	3	14	31	23	43	32	52	32	32	32	31
80	9	12	37	14	21	19	42	30	30	32	31
72	7	7	19	17	32	31	47	34	34	32	31
Average:		12	52	34	52	32	69	32	32	32	31

Table 12b

Breakdown: Education---Initial Time Study Training Received
With the Company.

Number of Raters: 45

Evaluation for consistency.

Average Ratings	Sequence Shown	$\pm 5\%$		$\pm 7\frac{1}{2}\%$		$\pm 10\%$		$\pm 20\%$	
		No.	%	No.	%	No.	%	No.	%
147	12	20	44	32	71	34	75	43	95
135	4	21	47	33	73	41	91	43	95
134	11	27	60	34	75	40	89	42	93
131	8	23	51	32	71	35	78	42	93
122	1	20	44	28	62	35	78	43	95
118	5	18	40	30	68	33	73	42	93
110	10	20	44	30	67	35	78	40	89
104	2	14	31	22	49	28	62	40	89
102	6	20	44	25	55	25	55	37	82
99	3	20	44	23	51	29	64	39	87
87	9	17	38	18	40	25	55	33	73
85	7	12	27	17	38	24	53	32	71
Average:		19	43%	27	60%	32	71%	40	88%

YOUNG JAMES TO: 101:111111

Year	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
1900	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100

Table 13a

Breakdown: Rater Uses His Own Concept of Standard Performance.

Number of Raters: 54

Evaluation for accuracy.

Corrected Sequence Ratings Shown		<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
153	12	24	44	32	59	35	65	51	94
142	4	24	44	25	46	33	61	50	93
136	11	27	50	36	67	45	83	50	93
130	8	23	43	35	65	43	80	49	91
121	1	24	44	36	67	43	80	49	91
117	5	24	44	37	68	38	70	51	94
104	10	12	22	23	43	30	55	49	91
97	2	20	37	28	52	37	68	48	89
94	6	17	32	21	39	23	43	43	80
92	3	19	35	22	41	28	52	47	87
80	9	13	23	16	30	23	43	38	70
78	7	13	23	20	37	24	44	38	70
Average:		20	37%	28	51%	34	62%	47	87%

Table 13a

Experimental Data for the Determination of the Effect of the

Number of Holes: 24

Evaluation for Accuracy

Corrected Sequence		±5%		±7 1/2%		±10%		±30%	
Rating	Score	No.	Score	No.	Score	No.	Score	No.	Score
100	10	24	44	32	29	32	62	21	64
140	4	24	44	32	46	32	61	20	62
150	11	27	20	28	27	42	63	20	63
150	8	27	43	32	62	42	63	48	61
151	1	24	44	30	67	42	60	48	61
117	2	24	44	27	66	38	70	21	64
104	10	12	23	23	42	30	22	49	61
97	2	20	27	28	22	27	68	48	66
94	6	17	22	21	20	22	47	42	60
92	2	19	22	23	41	26	22	47	67
80	2	13	22	18	20	23	42	28	70
78	7	13	23	20	27	24	44	26	70
Average:		20	27 1/2	28	21 1/2	34	62 1/2	47	67 1/2

Table 13b

Breakdown: Rater Uses His Own Concept of Standard Performance.

Number of Raters: 54

Evaluation for consistency.

Average Ratings	Sequence Shown	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
147	12	17	32	31	57	39	72	50	93
134	4	24	44	34	63	46	85	52	96
134	11	29	53	39	72	44	81	50	92
128	8	16	30	27	50	42	80	49	91
120	1	27	50	32	59	43	80	49	91
114	5	28	52	35	65	40	74	51	94
108	10	18	33	26	48	36	67	48	89
102	2	20	37	30	56	34	63	48	89
102	6	21	39	30	56	30	56	42	78
98	3	16	30	30	56	37	68	47	87
85	9	14	26	18	33	27	50	42	78
83	7	13	24	14	26	19	35	35	65
Average:		20	38%	29	53%	37	68%	47	87%

Explanations: 1. For comparison.
 Number of letters: 24
 Explanations: 1. For comparison.

Letters	Letters	Letters	Letters	Letters	Letters	Letters	Letters
147	147	147	147	147	147	147	147
148	148	148	148	148	148	148	148
149	149	149	149	149	149	149	149
150	150	150	150	150	150	150	150
151	151	151	151	151	151	151	151
152	152	152	152	152	152	152	152
153	153	153	153	153	153	153	153
154	154	154	154	154	154	154	154
155	155	155	155	155	155	155	155
156	156	156	156	156	156	156	156
157	157	157	157	157	157	157	157
158	158	158	158	158	158	158	158
159	159	159	159	159	159	159	159
160	160	160	160	160	160	160	160
161	161	161	161	161	161	161	161
162	162	162	162	162	162	162	162
163	163	163	163	163	163	163	163
164	164	164	164	164	164	164	164
165	165	165	165	165	165	165	165
166	166	166	166	166	166	166	166
167	167	167	167	167	167	167	167
168	168	168	168	168	168	168	168
169	169	169	169	169	169	169	169
170	170	170	170	170	170	170	170
171	171	171	171	171	171	171	171
172	172	172	172	172	172	172	172
173	173	173	173	173	173	173	173
174	174	174	174	174	174	174	174
175	175	175	175	175	175	175	175
176	176	176	176	176	176	176	176
177	177	177	177	177	177	177	177
178	178	178	178	178	178	178	178
179	179	179	179	179	179	179	179
180	180	180	180	180	180	180	180
181	181	181	181	181	181	181	181
182	182	182	182	182	182	182	182
183	183	183	183	183	183	183	183
184	184	184	184	184	184	184	184
185	185	185	185	185	185	185	185
186	186	186	186	186	186	186	186
187	187	187	187	187	187	187	187
188	188	188	188	188	188	188	188
189	189	189	189	189	189	189	189
190	190	190	190	190	190	190	190
191	191	191	191	191	191	191	191
192	192	192	192	192	192	192	192
193	193	193	193	193	193	193	193
194	194	194	194	194	194	194	194
195	195	195	195	195	195	195	195
196	196	196	196	196	196	196	196
197	197	197	197	197	197	197	197
198	198	198	198	198	198	198	198
199	199	199	199	199	199	199	199
200	200	200	200	200	200	200	200

Table 14a

Breakdown: Rater Uses Some Film or Other Embodiment of
Standard Performance.

Number of Raters: 15.

Evaluation for accuracy.

Corrected Sequence Ratings Shown		<u>+5%</u>		<u>+7½%</u>		<u>+10%</u>		<u>+20%</u>	
		No.	%	No.	%	No.	%	No.	%
155	12	8	53	14	93	15	100	15	100
143	4	4	27	8	53	14	93	15	100
137	11	11	73	11	73	14	93	15	100
131	8	9	60	12	80	12	80	15	100
122	1	8	53	10	67	12	80	15	100
118	5	5	33	11	73	13	87	15	100
104	10	6	40	8	53	11	73	15	100
98	2	10	67	11	73	13	87	15	100
95	6	8	53	9	60	11	73	15	100
92	3	5	33	7	47	8	53	14	93
81	9	2	13	3	20	4	27	13	87
79	7	4	27	6	40	8	53	14	93
Average:		7	44%	9	61%	11	75%	15	98%

Table 14a

Tested: Water Use Same Film or Other Embodiment of Standard Performance.

Number of Tests: 15.

Evaluation for Accuracy.

Rating	Corrected Sequence	No.				No.			
		±5%	±7½%	±10%	±12½%	±5%	±7½%	±10%	±12½%
123	12	8	23	14	92	10	100	12	100
143	4	37	8	23	14	92	12	100	100
137	11	11	73	11	73	14	92	12	100
131	8	60	12	80	12	80	12	100	100
132	1	8	23	10	67	12	80	12	100
118	2	2	23	11	73	12	87	12	100
104	10	40	8	23	11	73	12	100	100
89	3	10	87	11	73	12	87	12	100
88	6	8	23	9	60	11	72	12	100
82	2	2	23	7	47	8	23	14	82
81	8	8	12	2	20	4	27	12	87
79	7	4	27	6	40	8	23	14	82
Average:	7	44	8	21	21	11	72	12	82

Table 14b

Breakdown: Rater Uses Some Film or Other Embodiment of Standard Performance.

Number of Raters: 15

Evaluation for consistency.

Average Ratings	Sequence Shown	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
150	12	12	80	15	100	15	100	15	100
135	4	12	80	13	87	14	93	15	100
135	11	10	67	11	73	14	93	15	100
129	8	10	67	10	67	11	73	15	100
119	1	9	60	11	73	14	93	15	100
117	5	5	33	10	67	12	80	15	100
111	10	9	60	15	100	15	100	15	100
100	2	7	40	13	87	14	93	15	100
99	6	8	53	9	60	12	80	15	100
99	3	10	67	11	73	13	87	15	100
87	9	4	27	5	33	9	60	13	87
83	7	4	27	7	40	9	60	14	93
Average:		8	56%	11	72%	13	84%	15	98%

Table 14b

Breakdown: Water Used Some Film or Other Equipment of
Various Patterns.

Number of Water: 12

Estimation for comparison.

Estimate	Number of Water	Estimate	Number of Water	Estimate	Number of Water	Estimate	Number of Water
120	12	120	12	120	12	120	12
132	12	132	12	132	12	132	12
138	11	138	11	138	11	138	11
138	8	138	10	138	10	138	10
142	1	142	9	142	11	142	14
144	2	144	2	144	10	144	12
144	10	144	8	144	12	144	10
100	3	100	7	100	13	100	14
98	8	98	8	98	12	98	12
98	2	98	10	98	11	98	13
92	6	92	4	92	12	92	13
92	4	92	4	92	10	92	14
88	1	88	1	88	11	88	14
88	11	88	11	88	11	88	11

Table 15a

Breakdown: Plant employees number less than 101.

Number of raters: 10

Evaluation for accuracy.

Corrected Ratings	Sequence Shown	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
146	13	3	30	5	50	5	50	9	90
135	4	3	30	4	40	8	80	10	100
129	11	5	50	7	70	7	70	10	100
124	8	5	50	5	50	7	70	10	100
115	1	7	70	7	70	9	90	10	100
111	5	7	70	7	70	7	70	9	90
99	10	2	20	3	30	5	50	9	90
93	2	5	50	7	70	8	80	10	100
89	6	0	0	0	0	1	10	7	70
87	3	2	20	2	20	2	20	9	90
77	9	1	10	1	10	3	30	5	50
74	7	1	10	1	10	1	10	6	60
Average:		3	33%	4	41%	5	53%	9	87%

Table 12a

Trend: Plant employee number less than 101.
 Number of tests: 10
 Evaluation for accuracy.

Corrected Mean	No.	±2	±1	±10	±100	±300
108	10	2	20	2	20	2
120	4	2	30	4	20	10
130	11	2	20	7	70	10
140	8	2	20	2	70	10
150	1	7	70	7	20	10
160	2	7	70	7	20	2
170	10	2	20	3	20	2
180	3	2	20	7	70	10
190	2	2	20	2	20	2
200	2	2	20	2	20	2
210	2	2	20	2	20	2
220	2	2	20	2	20	2
230	2	2	20	2	20	2
240	2	2	20	2	20	2
250	2	2	20	2	20	2
260	2	2	20	2	20	2
270	2	2	20	2	20	2
280	2	2	20	2	20	2
290	2	2	20	2	20	2
300	2	2	20	2	20	2
310	2	2	20	2	20	2
320	2	2	20	2	20	2
330	2	2	20	2	20	2
340	2	2	20	2	20	2
350	2	2	20	2	20	2
360	2	2	20	2	20	2
370	2	2	20	2	20	2
380	2	2	20	2	20	2
390	2	2	20	2	20	2
400	2	2	20	2	20	2
410	2	2	20	2	20	2
420	2	2	20	2	20	2
430	2	2	20	2	20	2
440	2	2	20	2	20	2
450	2	2	20	2	20	2
460	2	2	20	2	20	2
470	2	2	20	2	20	2
480	2	2	20	2	20	2
490	2	2	20	2	20	2
500	2	2	20	2	20	2
510	2	2	20	2	20	2
520	2	2	20	2	20	2
530	2	2	20	2	20	2
540	2	2	20	2	20	2
550	2	2	20	2	20	2
560	2	2	20	2	20	2
570	2	2	20	2	20	2
580	2	2	20	2	20	2
590	2	2	20	2	20	2
600	2	2	20	2	20	2
610	2	2	20	2	20	2
620	2	2	20	2	20	2
630	2	2	20	2	20	2
640	2	2	20	2	20	2
650	2	2	20	2	20	2
660	2	2	20	2	20	2
670	2	2	20	2	20	2
680	2	2	20	2	20	2
690	2	2	20	2	20	2
700	2	2	20	2	20	2
710	2	2	20	2	20	2
720	2	2	20	2	20	2
730	2	2	20	2	20	2
740	2	2	20	2	20	2
750	2	2	20	2	20	2
760	2	2	20	2	20	2
770	2	2	20	2	20	2
780	2	2	20	2	20	2
790	2	2	20	2	20	2
800	2	2	20	2	20	2
810	2	2	20	2	20	2
820	2	2	20	2	20	2
830	2	2	20	2	20	2
840	2	2	20	2	20	2
850	2	2	20	2	20	2
860	2	2	20	2	20	2
870	2	2	20	2	20	2
880	2	2	20	2	20	2
890	2	2	20	2	20	2
900	2	2	20	2	20	2
910	2	2	20	2	20	2
920	2	2	20	2	20	2
930	2	2	20	2	20	2
940	2	2	20	2	20	2
950	2	2	20	2	20	2
960	2	2	20	2	20	2
970	2	2	20	2	20	2
980	2	2	20	2	20	2
990	2	2	20	2	20	2
1000	2	2	20	2	20	2

Table 15b

Breakdown: Plant employees number less than 101.

Number of raters: 10

Evaluation for consistency.

Average Ratings	Sequence Shown	<u>+5%</u>		<u>+7½%</u>		<u>+10%</u>		<u>+20%</u>	
		No.	%	No.	%	No.	%	No.	%
146	12	3	30	5	50	5	50	9	90
127	4	6	60	9	90	9	90	10	100
120	11	5	50	7	70	7	70	10	100
126	8	5	50	5	50	7	70	10	100
117	1	4	40	8	80	8	80	10	100
106	5	5	50	6	60	8	80	8	80
103	10	3	30	6	60	6	60	9	90
98	2	5	50	7	70	7	70	10	100
91	6	0	0	0	0	3	30	7	70
91	3	2	20	4	40	5	50	9	90
78	9	1	10	3	30	3	30	5	50
77	7	1	10	3	30	4	40	8	80
Average:		3	33%	5	53%	6	60%	9	86%

Table 12b

Bridgman: Plant employees number less than 101.

Number of ratings: 10

Evaluation for consistency.

Rating	Average	No.	±10%	No.	±15%	No.	±10%	No.	±20%
146	12	3	20	2	30	2	20	2	20
137	4	6	40	2	80	2	60	10	100
130	11	2	30	7	70	7	70	10	100
129	6	6	20	2	20	7	70	10	100
117	1	4	40	8	20	8	80	10	100
104	8	2	20	8	20	8	80	8	80
103	10	2	30	2	80	8	80	8	80
98	3	2	20	7	70	7	70	10	100
91	6	0	0	0	0	7	70	7	70
91	2	2	20	4	40	2	20	2	20
76	6	1	10	2	20	2	20	2	20
77	7	1	10	2	30	4	40	6	60
Average:		3	20	2	25	6	60	2	20

Table 16a

Breakdown: Plant employees number 101-1000.

Number of raters: 37.

Evaluation for accuracy.

Corrected Ratings	Sequence Shown	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±30%</u>	
		No.	%	No.	%	No.	%	No.	%
153	12	20	54	24	65	26	70	34	92
141	4	15	41	23	63	25	68	33	84
135	11	20	54	27	73	30	81	33	84
130	8	15	41	23	60	29	78	32	87
120	1	20	54	25	68	31	84	33	84
116	5	19	51	25	68	28	76	35	95
103	10	6	16	13	35	15	41	34	92
97	2	15	41	20	54	28	76	34	92
93	6	15	41	16	43	19	51	32	87
91	3	15	41	20	54	23	63	30	81
80	9	10	27	11	30	16	43	28	76
78	7	8	23	17	46	20	54	29	78
Average:		15	40%	20	55%	24	65%	32	87%

1911

Reference: 9201 0010768 10000 101-1000.

.78 :mrtat h0 rcdpr

...for the purpose of...

Year	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	

Table 16b

Breakdown: Plant employees number 101-1000.

Number of raters: 37.

Evaluation for consistency.

Average Ratings	Sequence Shown	$\pm 5\%$		$\pm 7\frac{1}{2}\%$		$\pm 10\%$		$\pm 20\%$	
		No.	%	No.	%	No.	%	No.	%
144	12	15	41	20	54	29	78	34	92
134	4	19	51	24	65	31	84	35	95
133	11	24	65	28	76	31	84	33	89
138	8	11	30	19	51	29	78	32	87
119	1	21	57	28	76	31	84	33	89
117	5	16	43	25	68	27	73	35	95
109	10	14	38	21	57	26	70	32	87
100	2	16	43	21	57	27	73	34	92
101	6	14	38	19	51	23	62	31	84
96	3	16	43	18	49	23	62	31	84
85	9	9	24	11	30	19	51	28	76
82	7	16	43	17	46	18	49	26	70
Average:		16	43%	21	57%	26	71%	32	86%

Table 12b

Breakdown: Plant employees number 101-1000.

Number of tests: 27.

Evaluation for consistency.

Average Rating	Deviation	No.	No.	No.	No.	No.	No.
144	18	18	41	80	24	29	78
134	4	18	21	24	29	21	84
133	11	84	29	28	78	21	84
138	8	11	30	18	21	29	78
110	1	21	27	28	78	21	84
117	2	18	43	28	28	27	78
109	10	14	38	21	27	28	70
100	5	18	29	21	27	27	73
101	8	14	38	18	21	28	63
98	3	18	43	18	48	28	63
88	9	8	24	11	30	18	21
89	7	18	43	17	48	18	48
Average:		18	43	31	27	28	71

Table 17a

Breakdown: Plant employees number greater than 1000.

Number of raters: 21

Evaluation for accuracy.

Corrected Sequence Ratings: Shown		<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
156	12	13	57	14	67	16	76	21	100
144	4	7	33	12	57	16	76	21	100
138	11	9	43	12	57	17	81	20	96
133	8	12	57	15	72	16	76	21	100
123	1	10	48	13	62	14	67	21	100
119	5	12	57	13	62	14	67	21	100
106	10	11	54	15	72	16	76	19	91
99	2	9	43	10	48	14	67	18	86
96	6	10	48	12	57	12	57	16	76
93	3	6	29	8	38	9	43	19	91
82	9	4	19	7	33	7	33	14	67
79	7	1	5	5	24	7	33	16	76
Average:		9	41%	11	54%	13	63%	19	90%

Table 17b

Breakdown: Plant employees number greater than 1000.

Number of raters: 21

Evaluation for consistency.

Average Ratings	Sequence Shown	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
149	12	13	62	14	67	20	96	21	100
136	4	14	67	17	81	20	96	21	100
135	11	10	48	13	62	20	96	21	100
130	8	11	53	15	72	16	76	21	100
123	1	10	48	13	62	14	67	21	100
117	5	9	43	12	57	14	67	20	96
108	10	10	48	15	72	17	81	19	91
106	2	6	29	11	53	14	67	19	91
104	6	7	33	12	57	13	62	18	86
101	3	12	57	13	62	17	81	20	96
82	9	7	33	11	53	12	57	18	86
85	7	6	29	9	43	11	53	16	76
Average:		10	46%	13	62%	16	75%	20	94%

Table 17b

Number of subjects whose scores are greater than 1000.

Number of subjects: 51

Deviation for consistency.

Average score	Deviation shown	±50				±75				±100				±125			
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
100	3	6	12	3	6	11	22	11	22	14	28	14	28	18	35	18	35
95	5	7	14	4	8	12	24	10	20	16	32	16	32	20	40	20	40
90	6	7	14	5	10	13	26	12	24	18	36	18	36	22	44	22	44
85	7	8	16	6	12	14	28	14	28	20	40	20	40	24	48	24	48
80	8	9	18	7	14	15	30	15	30	22	44	22	44	26	52	26	52
75	9	10	20	8	16	16	32	16	32	24	48	24	48	28	56	28	56
70	10	10	20	9	18	17	34	17	34	26	52	26	52	30	60	30	60
65	10	9	18	8	16	16	32	16	32	24	48	24	48	28	56	28	56
60	11	8	16	7	14	15	30	15	30	22	44	22	44	26	52	26	52
55	12	7	14	6	12	14	28	14	28	20	40	20	40	24	48	24	48
50	13	6	12	5	10	13	26	13	26	18	36	18	36	22	44	22	44
45	14	5	10	4	8	12	24	12	24	16	32	16	32	20	40	20	40
40	15	4	8	3	6	11	22	11	22	14	28	14	28	18	35	18	35
35	16	3	6	2	4	10	20	10	20	12	24	12	24	16	32	16	32
30	17	2	4	1	2	9	18	9	18	10	20	10	20	14	28	14	28
25	18	1	2	1	2	8	16	8	16	9	18	9	18	12	24	12	24
20	19	1	2	1	2	7	14	7	14	8	16	8	16	10	20	10	20
15	20	1	2	1	2	6	12	6	12	7	14	7	14	8	16	8	16
10	21	1	2	1	2	5	10	5	10	6	12	6	12	7	14	7	14
5	22	1	2	1	2	4	8	4	8	5	10	5	10	6	12	6	12
0	23	1	2	1	2	3	6	3	6	4	8	4	8	5	10	5	10

Table 18a

Breakdown: Size of town less than 5000.

Number of raters: 17

Evaluation for accuracy.

Corrected Ratings	Sequence Shown	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
150	12	14	83	15	88	15	88	17	100
139	4	8	47	13	77	14	83	17	100
133	11	13	71	14	83	16	94	17	100
128	8	4	24	8	47	13	75	16	94
119	1	13	77	15	88	15	88	17	100
114	5	10	59	13	75	15	88	16	94
102	10	3	18	5	29	5	29	16	94
95	2	8	47	10	59	15	88	17	100
92	6	6	35	6	35	6	35	16	94
90	3	6	35	13	71	13	75	16	94
79	9	4	24	6	35	6	35	13	71
77	7	7	41	10	59	11	65	14	83
Average:		8	47%	11	62%	12	71%	16	94%

Table 18

Frequency: Five of less than 2000.

Number of returns: 17

Estimated for accuracy.

Corrected Results		Frequency		±2		±3		±10		±20	
No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
160	13	14	83	15	88	12	68	12	68	12	100
158	4	8	47	13	77	14	68	17	68	17	100
155	11	15	71	14	83	12	64	17	64	17	100
152	8	4	24	8	47	13	72	12	68	12	68
148	4	12	77	15	88	15	68	17	68	17	100
144	5	10	59	12	72	12	68	12	68	12	68
102	10	3	19	5	29	2	32	12	64	12	64
82	4	8	47	10	59	12	68	17	68	17	100
62	2	6	35	6	35	8	48	12	64	12	64
52	3	6	35	12	71	13	72	12	64	12	64
42	5	4	24	6	35	8	48	12	64	12	64
32	2	2	11	10	59	11	65	12	64	12	64
22	2	2	11	11	65	12	71	12	64	12	64

Table 18b

Breakdown: Size of town less than 5000.

Number of raters: 17.

Evaluation for consistency.

Average Ratings	Sequence Shown	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
146	12	11	65	15	88	15	88	17	100
134	4	9	53	12	71	13	77	17	100
134	11	12	71	14	83	15	88	17	100
128	8	4	24	8	47	13	77	16	94
119	1	13	77	15	88	15	88	17	100
112	5	7	41	11	65	14	83	16	94
109	10	7	41	11	65	14	83	16	94
98	2	11	65	12	71	14	83	17	100
93	6	6	35	8	35	8	47	16	94
90	3	6	35	12	71	13	77	16	94
82	9	6	35	9	53	10	59	13	77
77	7	7	41	10	59	11	65	14	83
Average:		8	49%	11	66%	14	81%	16	94%

TABLE 12

Geographic: Size of town less than 2000.

Number of tests: 17.

Estimates for consistency.

Rating	Standard	±100	±100	±100	±100	±100	±100	±100	±100
140	13	11	11	11	11	11	11	11	11
130	4	2	2	2	2	2	2	2	2
120	11	13	13	13	13	13	13	13	13
110	1	13	13	13	13	13	13	13	13
100	2	7	41	11	63	14	83	13	84
90	10	7	41	11	63	14	83	13	84
80	3	11	63	14	83	13	84	13	100
70	6	6	32	8	32	8	47	13	64
60	3	6	32	13	71	13	77	13	64
50	6	6	32	8	32	10	59	13	77
40	7	7	41	10	59	11	63	14	83
Average	8	13	11	11	11	11	11	11	11

Table 19a

Breakdown: Size of town 5000 - 10,000.

Number of raters: 7.

Evaluation for accuracy.

Corrected Ratings	Sequence Shown.	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
161	12	2	29	2	29	2	29	6	86
149	4	0	0	1	14	2	29	6	86
143	11	3	43	3	43	4	57	6	86
137	8	1	14	4	57	6	86	6	86
137	1	2	29	3	43	4	57	7	100
133	5	4	57	5	71	5	71	6	86
109	10	2	29	4	57	5	71	6	86
102	2	2	29	3	43	4	57	6	86
99	6	2	29	2	29	5	71	6	86
96	3	1	14	1	14	3	43	6	86
84	9	1	14	2	29	3	43	4	57
82	7	3	43	3	43	3	43	5	71
Average:		2	37%	3	39%	4	55%	6	83%

Table 19a

Programs: Size of team 2000 - 10,000.

Number of tapes: 7.

Estimation for accuracy:

	Corrected variance	No.	±5%		±10%		±15%	
			No.	%	No.	%	No.	%
181	13	8	29	2	29	2	30	2
148	4	3	2	1	18	2	27	2
143	11	2	43	2	42	4	37	2
137	2	1	14	4	27	2	28	2
127	1	2	32	2	43	4	27	7.100
123	2	4	27	2	27	2	27	2
102	10	2	23	4	27	2	27	2
101	2	2	22	2	43	4	27	2
78	2	2	23	2	23	2	27	2
68	2	1	14	1	14	2	43	2
64	0	1	14	2	23	2	43	2
63	7	2	43	2	43	2	43	2
55	2	2	24	2	23	4	27	2

Table 19b

Breakdown: Size of town 5,000 - 10,000.

Number of raters: 7.

Evaluation for consistency.

Average Ratings	Sequence Shown	$\pm 5\%$		$\pm 7\frac{1}{2}\%$		$\pm 10\%$		$\pm 20\%$	
		No.	%	No.	%	No.	%	No.	%
153	12	1	14	3	43	4	57	6	86
138	4	2	29	4	57	6	86	6	86
140	11	3	43	4	57	4	57	6	86
137	8	1	14	4	57	6	86	6	86
124	1	3	43	4	57	5	71	7	100
123	5	4	57	5	71	5	71	6	86
117	10	3	43	3	43	3	43	6	86
106	2	3	43	3	43	4	57	6	86
104	6	3	43	4	57	4	57	6	86
110	3	5	71	5	71	5	71	6	86
89	9	2	29	2	29	3	43	4	57
86	7	2	29	3	43	3	43	5	71
Average:		3	38%	4	52%	4	62%	6	83%

TABLE 126

Proportion of total 2,000 - 10,000

Number of plants, N.

Explanations for consistency.

Average Height	Average Growth	±2	±1 1/2	±1 1/4	±1 1/8	±1/2
No.	No.	No.	No.	No.	No.	No.
153	13	1	14	2	43	4
150	4	2	83	4	27	8
140	11	3	43	4	27	4
137	8	1	14	4	27	8
134	1	3	43	4	27	2
132	2	4	27	2	71	2
117	10	3	43	2	43	2
106	3	3	43	2	43	4
104	4	2	43	4	27	4
110	3	8	71	8	71	2
99	8	3	20	3	43	4
88	7	3	20	3	43	2
87		2	28	4	27	8

Table 20a

Breakdown: Size of town 10,000 - 25,000.

Number of raters: 19

Evaluation for accuracy.

Corrected Ratings	Sequence Shown	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
153	12	8	42	11	58	12	63	19	100
142	4	7	37	9	47	12	63	19	100
138	11	9	47	12	63	16	84	19	100
130	8	8	42	11	58	16	84	19	100
121	1	8	42	15	79	18	95	19	100
117	5	8	42	10	53	14	74	19	100
104	10	5	26	8	42	12	63	17	90
97	2	6	32	8	42	9	47	19	100
94	6	7	37	8	42	8	42	16	84
92	3	1	5	2	11	5	26	16	84
80	9	3	16	3	16	6	32	12	63
78	7	1	5	5	26	7	37	15	79
Average:		6	31%	9	45%	11	59%	17	92%

Table 202

Frequency: size of town 10,000 - 25,000.

Number of houses 12

Population for housing.

Cottages, houses, and other buildings		+25		+15		+10		+5	
No.	%	No.	%	No.	%	No.	%	No.	%
120	12	0	45	11	38	12	62	19	100
140	4	7	37	8	47	13	63	19	100
150	11	6	47	12	62	13	64	19	100
155	5	8	44	11	38	18	64	19	100
157	7	6	42	12	73	18	58	19	100
117	2	8	43	10	52	14	74	19	100
104	10	5	39	8	47	13	62	17	60
87	8	3	32	8	43	9	47	19	100
84	6	7	37	8	43	8	42	18	84
63	5	1	2	3	11	6	34	19	86
58	8	3	12	3	13	5	35	18	62
48	7	1	6	2	10	7	37	13	73
Total:		6	214	3	194	11	554	17	834

Table 20b

Breakdown: Size of town 10,000 - 25,000

Number of raters: 19

Evaluation for consistency.

Average Ratings	Sequence Shown	±5%		±7½%		±10%		±20%	
		No.	%	No.	%	No.	%	No.	%
146	12	2	11	12	63	13	69	19	100
132	4	10	53	17	90	18	95	19	100
133	11	10	53	16	84	18	95	19	100
126	8	6	32	10	53	15	79	19	100
122	1	9	47	14	74	18	95	19	100
115	5	8	42	10	53	16	84	19	100
105	10	7	37	8	42	12	63	18	95
104	2	5	26	10	53	13	69	19	100
103	6	6	32	12	63	14	74	16	84
98	3	4	21	12	63	13	69	17	90
85	9	4	21	4	21	8	42	15	79
85	7	7	37	10	53	11	58	14	74
Average:		7	34%	11	59%	14	74%	18	94%

606 10

000,89 - 000,01 milia de reais : 7-06-98

81-10000-10-73000

THE UNIVERSITY OF CHICAGO

[illegible]

Table 21a

Breakdown: Size of town 25,000 - 50,000.

Number of Raters: 10.

Evaluation for accuracy.

Corrected Ratings	Sequence Shown.	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
153	13	4	40	7	70	7	70	10	100
141	4	6	60	7	70	8	80	9	90
135	11	5	50	6	60	9	90	9	90
130	8	3	30	7	70	8	80	9	90
121	1	4	40	5	50	6	60	10	100
117	5	2	20	4	40	4	40	10	100
104	10	4	40	5	50	7	70	9	90
97	2	4	40	6	60	8	80	8	80
94	6	3	30	6	60	6	60	6	60
92	3	6	60	7	70	8	80	9	90
80	9	4	40	5	50	6	60	7	70
78	7	2	20	3	30	4	40	7	70
Average:		4	39%	6	57%	7	68%	9	86%

Table 21b

Breakdown: Size of town 25,000 - 50,000.

Number of raters: 10.

Evaluation for consistency.

Average Ratings	Sequence Shown	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
147	12	4	40	5	50	6	60	10	100
133	4	6	60	8	80	9	90	10	100
134	11	5	50	6	60	9	90	9	90
126	8	1	10	4	40	7	70	9	90
120	1	4	40	5	50	7	70	10	100
117	5	2	20	4	40	4	40	10	100
106	10	3	30	7	70	8	80	9	90
102	2	4	40	6	60	6	60	8	80
106	6	0	0	2	20	5	50	8	80
97	3	4	40	6	60	8	80	10	100
85	9	3	30	4	40	6	60	8	80
81	7	4	40	4	40	4	40	7	70
Average:		3	33%	5	51%	7	66%	9	90%

Table 22a

Breakdown: Size of town 50,000 - 100,000.

Number of raters: 7.

Evaluation for accuracy.

Corrected Ratings	Sequence Shown	$\pm 5\%$		$\pm 7\frac{1}{2}\%$		$\pm 10\%$		$\pm 20\%$	
		No.	%	No.	%	No.	%	No.	%
159	12	5	71	5	71	7	100	7	100
147	4	3	43	3	43	4	57	7	100
141	11	3	43	7	100	7	100	7	100
136	8	4	57	5	71	7	100	7	100
126	1	3	43	4	57	4	57	6	85
121	5	4	57	4	57	6	85	7	100
108	10	3	43	3	43	4	57	6	85
101	2	1	14	3	43	6	85	6	85
98	6	0	0	4	57	5	71	7	100
95	3	2	28	2	28	3	43	7	100
83	9	0	0	1	14	3	43	6	85
81	7	1	14	1	14	1	14	5	71
Average:		2	35%	4	50%	5	68%	7	93%

Table 22a

Breakdown: Five at town 20,000 - 100,000.

Number of cases: 7.

Evaluation for country.

Rating	Corrected Rating	No.				No.			
		100		100		100		100	
156	13	2	71	2	71	7	100	7	100
147	4	2	43	2	43	4	87	7	100
141	11	2	43	7	100	7	100	7	100
138	8	4	87	7	71	7	100	7	100
136	1	2	43	4	87	4	87	8	85
131	2	4	87	4	87	8	88	7	100
103	10	2	43	2	43	4	87	8	85
101	3	1	14	2	43	3	85	8	85
98	8	2	0	4	87	2	71	7	100
95	3	2	23	3	23	3	43	7	100
93	8	0	0	1	14	2	43	8	85
81	7	1	14	1	14	1	14	2	71
Average:	8	35	4	50	2	88	7	53	

Table 22b

Breakdown: Size of town 50,000 - 100,000

Number of raters: 7.

Evaluation for consistency.

Average Ratings	Sequence Shown	<u>+5%</u>		<u>+7½%</u>		<u>+10%</u>		<u>+20%</u>	
		No.	%	No.	%	No.	%	No.	%
154	12	5	71	7	100	7	100	7	100
137	4	3	43	5	71	7	100	7	100
139	11	3	43	6	85	7	100	7	100
133	8	5	71	6	85	6	85	7	100
118	1	3	43	5	71	5	71	5	71
121	5	4	57	4	57	6	85	7	100
117	10	3	43	5	71	5	71	7	100
101	2	1	14	3	43	6	85	6	85
103	6	3	43	4	57	4	57	7	100
101	3	2	28	4	57	6	85	7	100
96	9	3	43	5	71	6	85	6	85
93	7	4	57	4	57	4	57	7	100
Average:		3	46%	5	69%	6	82%	7	95%

Table 282

Blockdown: Size of town 50,000 - 100,000

Number of voters: 7.

Evaluation for consistency.

Average Rating	Standard Deviation	No.	%	+5	No.	%	+10	No.	%	+15	No.	%	
124	12	5	71	7	100	7	100	7	100	7	100	7	100
127	4	3	43	5	71	7	100	7	100	7	100	7	100
129	11	3	43	6	85	7	100	7	100	7	100	7	100
133	8	5	71	6	85	6	85	6	85	7	100	7	100
118	1	2	43	5	71	5	71	5	71	5	71	5	71
131	2	4	57	4	57	6	85	6	85	7	100	7	100
117	10	5	43	5	71	5	71	5	71	7	100	7	100
101	3	1	14	3	43	6	85	6	85	6	85	6	85
103	6	3	43	4	57	4	57	4	57	7	100	7	100
101	3	3	38	4	57	6	85	6	85	7	100	7	100
88	9	3	43	5	71	6	85	6	85	6	85	6	85
93	7	4	57	4	57	4	57	4	57	7	100	7	100
Average:		3	43	5	68	6	85	6	85	7	85	7	85

Table 23a

Breakdown: Size of town over 100,000.

Number of raters: 11.

Evaluation for accuracy.

Corrected Ratings	Sequence Shown	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
154	12	2	18	4	36	5	46	7	64
142	4	3	27	3	27	4	36	8	73
136	11	2	18	4	36	6	55	8	73
131	8	5	46	5	46	5	46	7	64
121	1	2	18	4	36	7	64	8	73
117	5	2	18	4	36	5	46	9	82
104	10	3	27	6	55	6	55	9	82
97	2	8	73	8	73	8	73	8	73
94	6	5	46	6	55	6	55	9	82
92	3	4	36	5	46	5	46	8	73
80	9	2	18	2	18	4	36	9	82
78	7	2	18	4	36	5	46	8	73
Average:		3	30%	5	42%	6	50%	8	74%

Table 22a

Breakdown: Size of town over 100,000.

Number of voters: 11.

Evaluation for accuracy.

Voters:	Corrected Rating		Sequence shown		154		157		158		159		160	
	No.	1	No.	2	No.	3	No.	4	No.	5	No.	6	No.	7
154	18	18	3	18	4	32	5	46	6	50	7	54	8	58
143	4	37	3	37	4	37	5	41	6	45	7	49	8	53
138	11	18	3	18	4	32	5	46	6	50	7	54	8	58
131	8	46	5	46	6	50	7	54	8	58	9	62	10	66
121	1	18	3	18	4	32	5	46	6	50	7	54	8	58
117	5	18	3	18	4	32	5	46	6	50	7	54	8	58
104	10	37	3	37	4	37	5	41	6	45	7	49	8	53
97	3	73	8	73	9	77	10	81	11	85	12	89	13	93
94	6	48	5	48	6	52	7	56	8	60	9	64	10	68
93	3	32	4	32	5	36	6	40	7	44	8	48	9	52
80	8	18	3	18	4	32	5	46	6	50	7	54	8	58
78	7	18	3	18	4	32	5	46	6	50	7	54	8	58
Average:	3	304	5	484	6	504	7	524	8	544	9	564	10	584

Table 23b

Breakdown: Size of town over 100,000.

Number of raters: 11.

Evaluation for consistency.

Average Ratings	Sequence Shown	<u>±5%</u>		<u>±7½%</u>		<u>±10%</u>		<u>±20%</u>	
		No.	%	No.	%	No.	%	No.	%
149	12	4	36	5	46	5	46	7	64
138	4	3	27	4	36	5	46	8	73
131	11	4	36	6	55	6	55	8	73
128	8	5	46	5	46	6	55	7	64
120	1	3	27	5	46	7	64	8	73
107	5	4	36	5	46	8	73	9	82
109	10	4	36	5	46	5	46	8	73
103	2	5	46	5	46	6	55	8	73
100	6	5	46	6	55	6	55	8	73
101	3	4	36	4	36	6	55	7	64
87	9	2	18	2	18	4	36	7	64
83	7	2	18	2	18	2	18	6	55
Average:		4	34%	5	41%	6	50%	8	69%

Table 236

Trucks: Size of town over 100,000.

Number of trucks: 11.

Navigation for commercial.

Rating	Average	Deviation	±10%	±15%	±20%	±25%	±30%
No.	No.	No.	No.	No.	No.	No.	No.
148	13	4	20	20	20	20	20
158	4	3	27	36	36	36	36
171	11	4	26	26	26	26	26
178	3	5	48	48	48	48	48
179	1	3	27	46	46	46	46
187	5	4	26	46	46	46	46
188	10	4	36	46	46	46	46
191	5	5	46	46	46	46	46
192	8	5	46	46	46	46	46
193	3	4	36	36	36	36	36
194	7	7	26	26	26	26	26
195	3	3	18	18	18	18	18
196	7	3	18	18	18	18	18
197	4	3	41	41	41	41	41

Table 24

Results of Analysis-of-Variance Tests

Breakdown	F_{c05}	F_{c10}	F_{05}	Significant
Area	3.21	6.64	2.95	Yes
Experience	1.11	1.67	2.88	No
Education	6.48	7.11	243- F_{c05} 4.84 F_{c10}	At 10%
Concept of "standard performance"	3.05	8.64	4.84	At 10%
No. of employees	1.03	3.30	3.44	No
Size of city	2.03	2.60	2.38	Barely at 10%

F_{c05} and F_{c10} indicate computed F 's at the $\pm 5\%$ and $\pm 10\%$ levels of accuracy.

F_{05} is tabulated values of F at the 5% level of significance.

Table 24

Results of Analysis of Variance Tests

Source of Variation	df	SS	MS	F	Significant
Between	1	3.21	3.21	8.84	Yes
Within	11	1.11	0.10		No
Total	12	4.32			
Between	1	7.11	7.11	243.700	At 10%
Within	11	4.87	0.44		
Total	12	11.98			
Between	1	8.84	8.84	4.84	At 10%
Within	11	3.30	0.30		No
Total	12	12.14			
Between	1	2.03	2.03	5.38	At 10%
Within	11	4.11	0.37		
Total	12	6.14			

10% and 5% indicate computed F's at the 10% and 5% levels of accuracy.

F05 is tabulated values of F at the 5% level of

significance.

Fig. 1

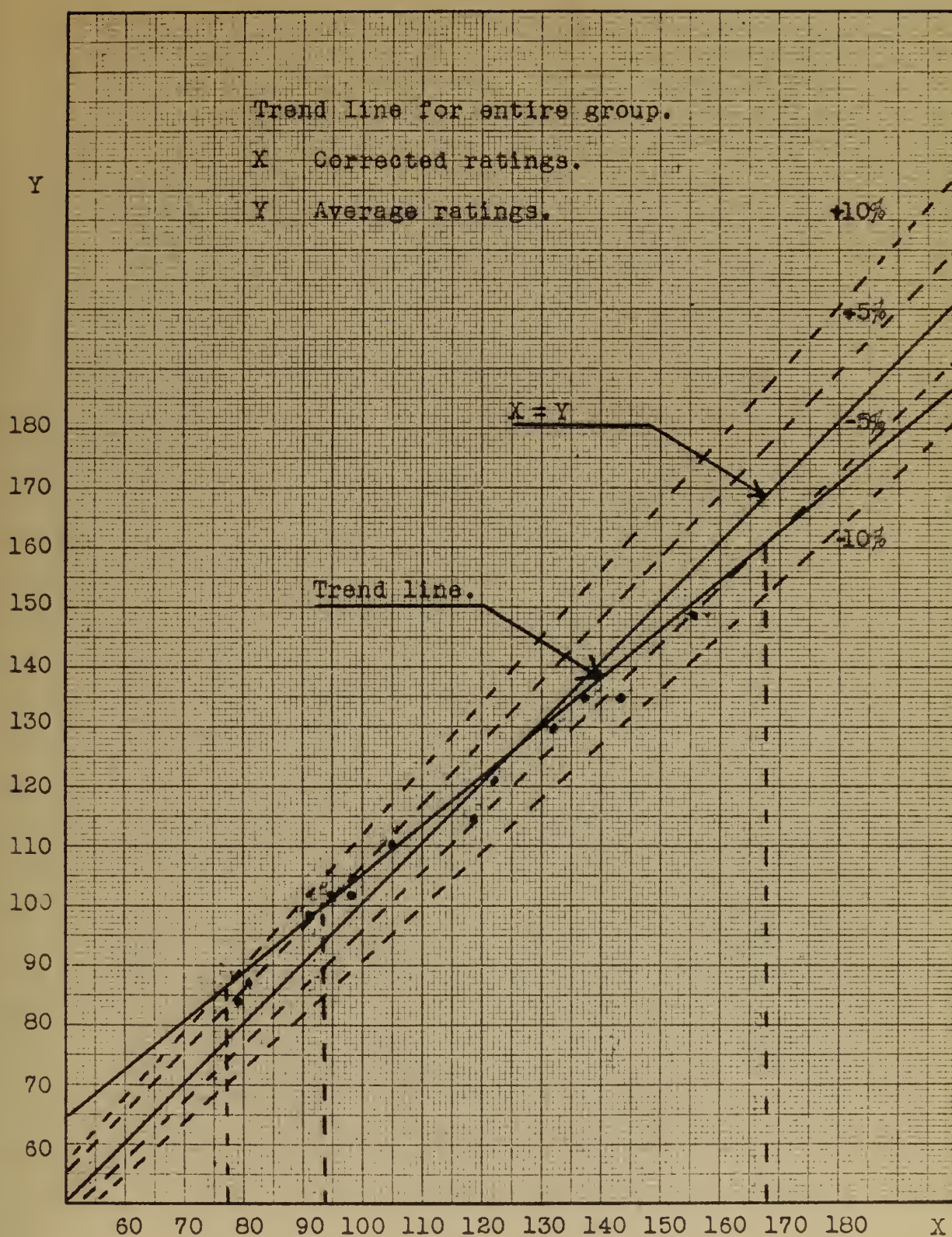


Fig. 2

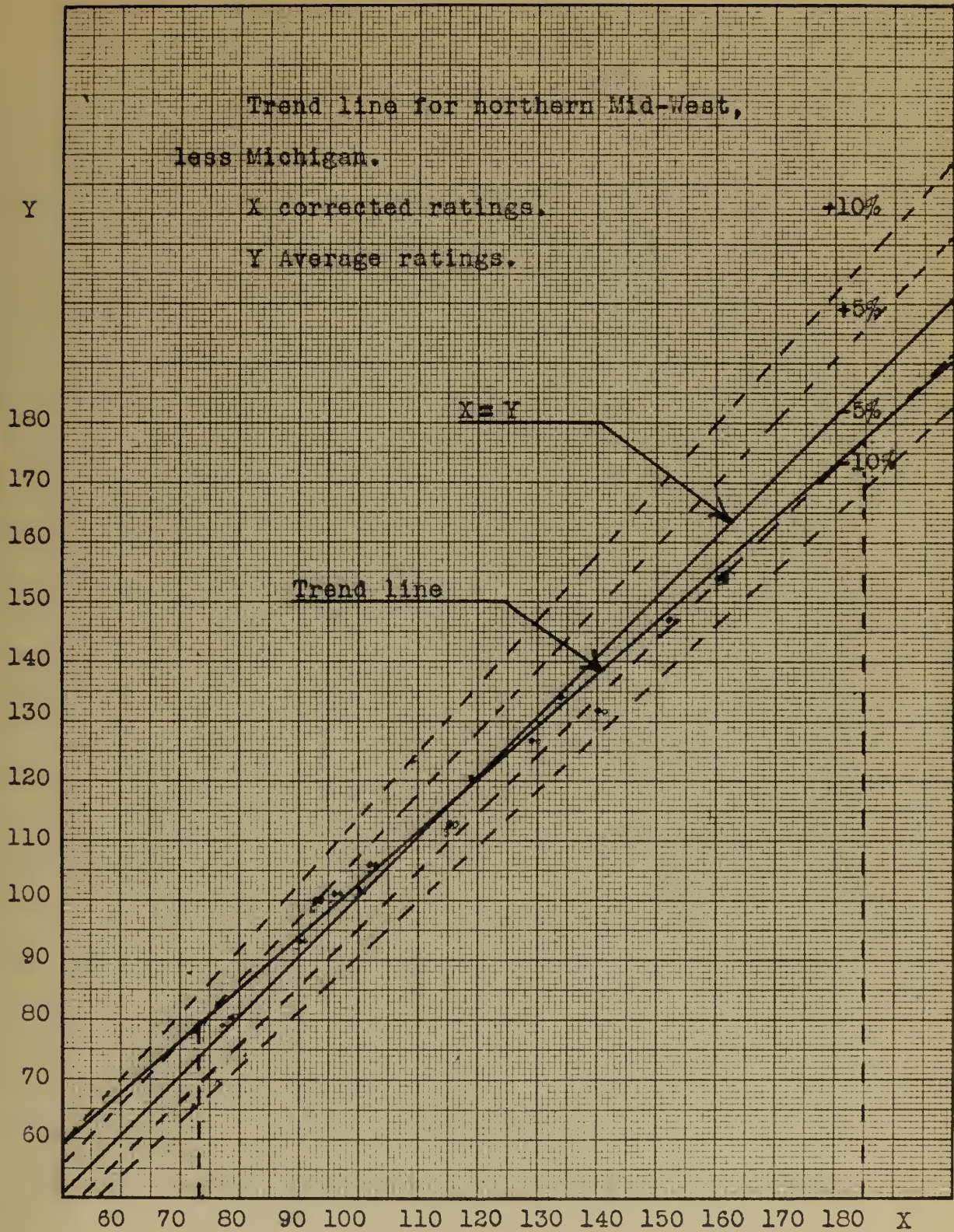


Fig. 3

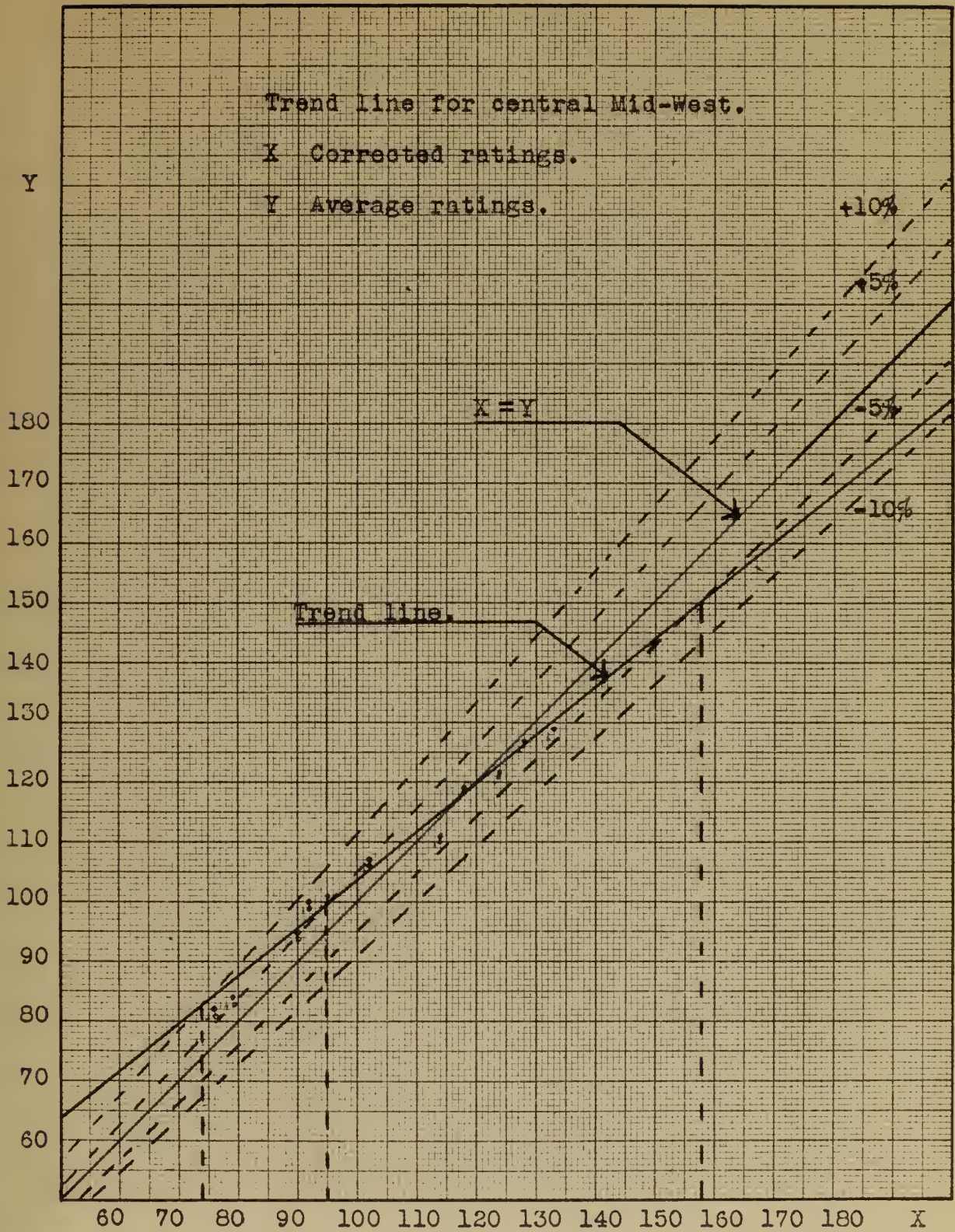


Fig. 4

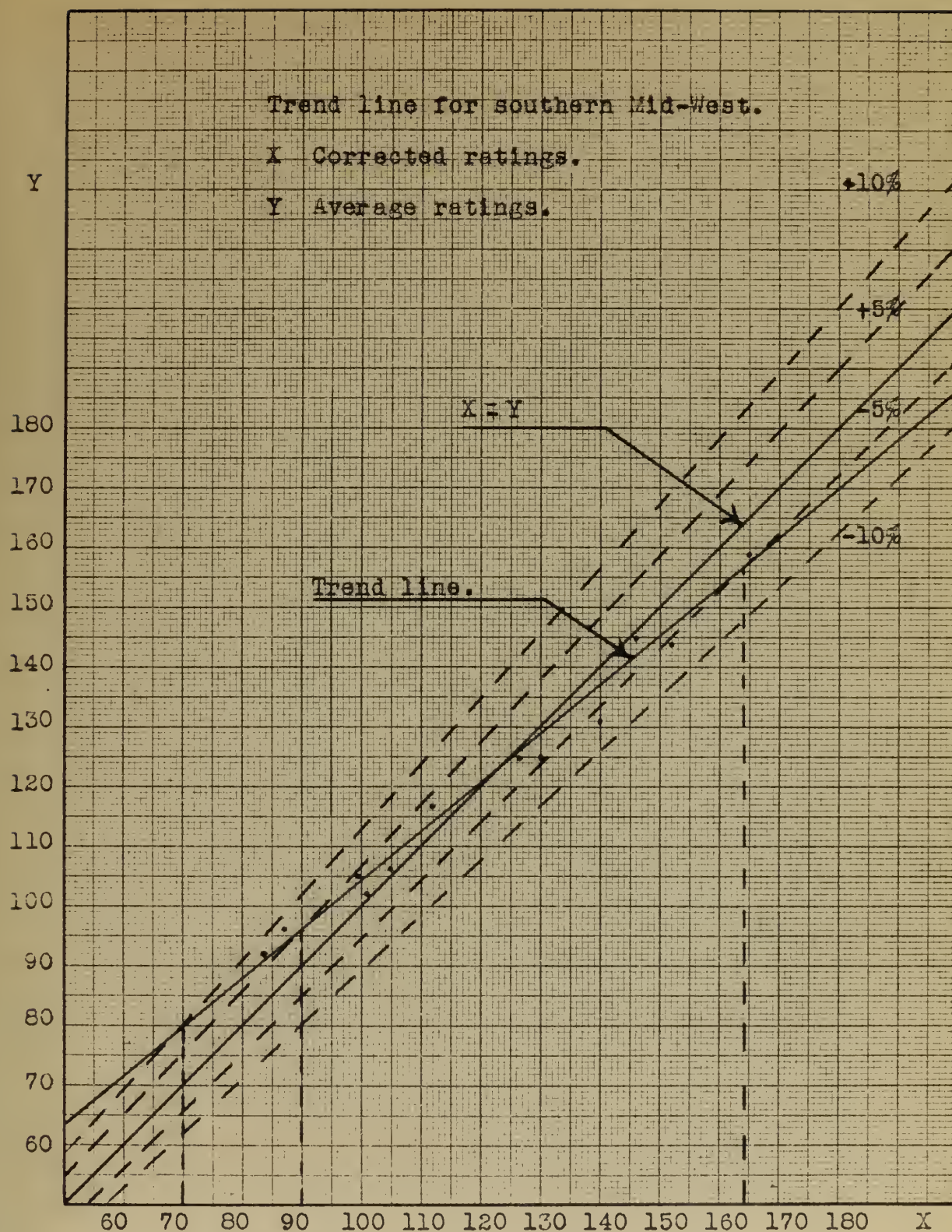


Fig. 5

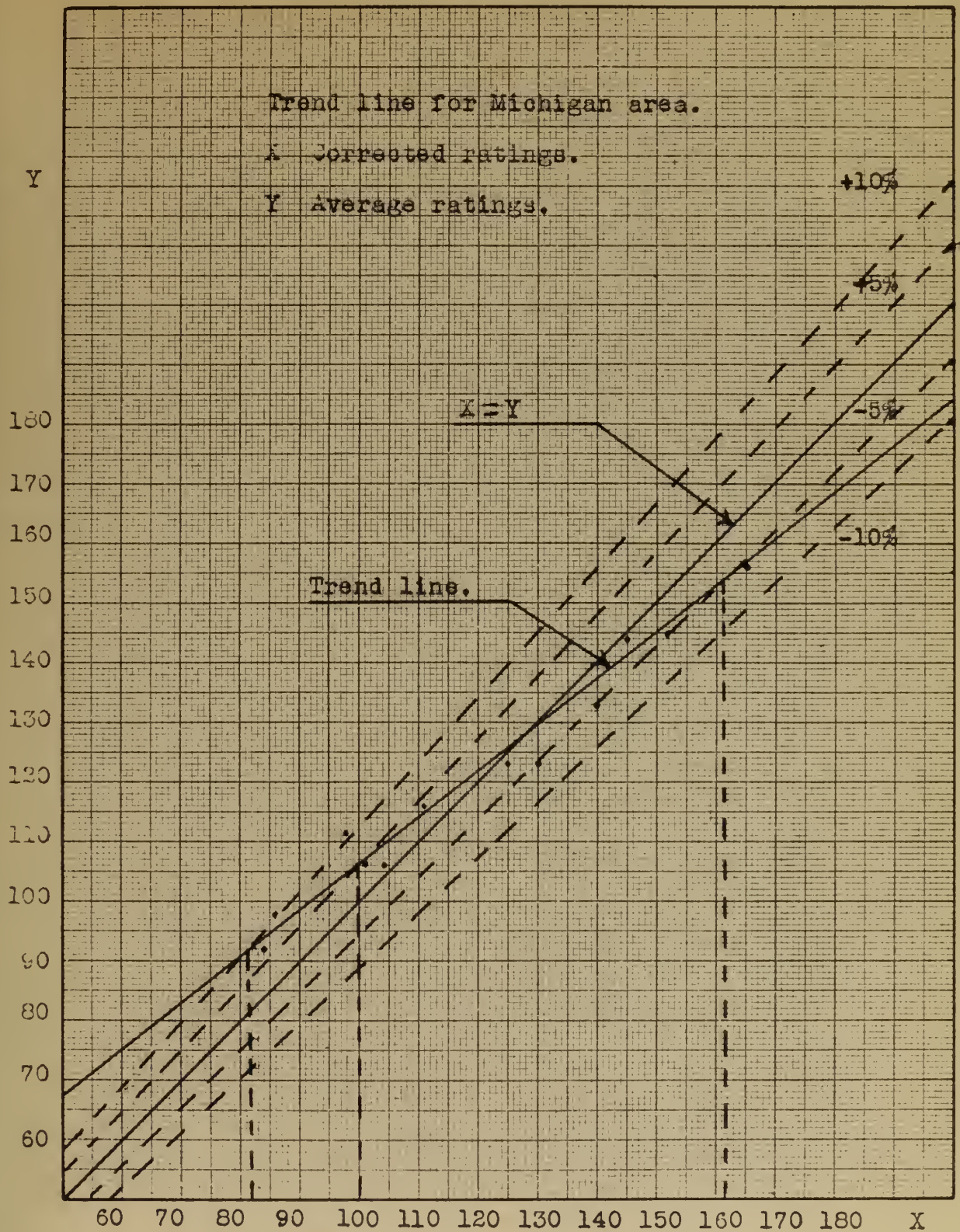


Fig. 6

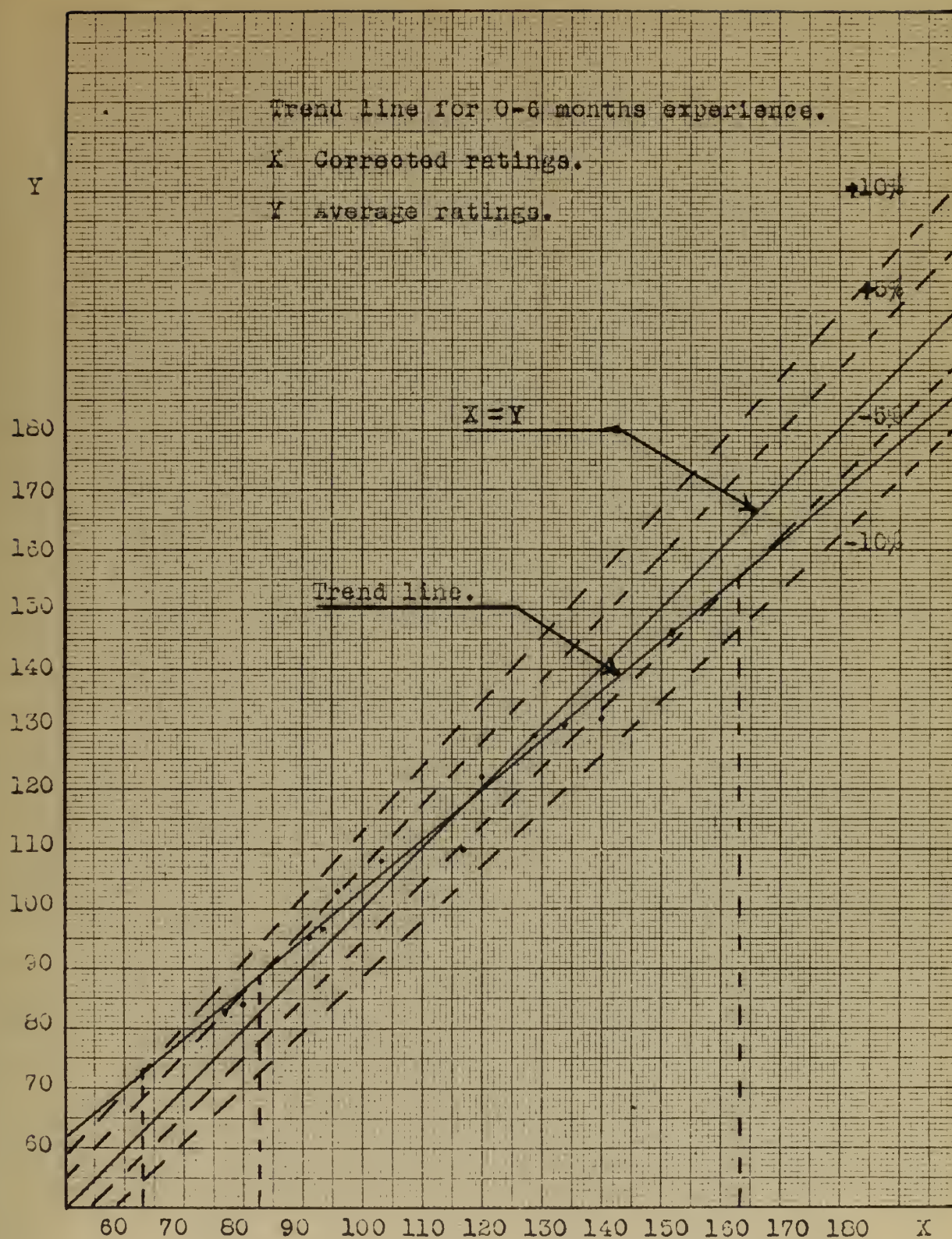
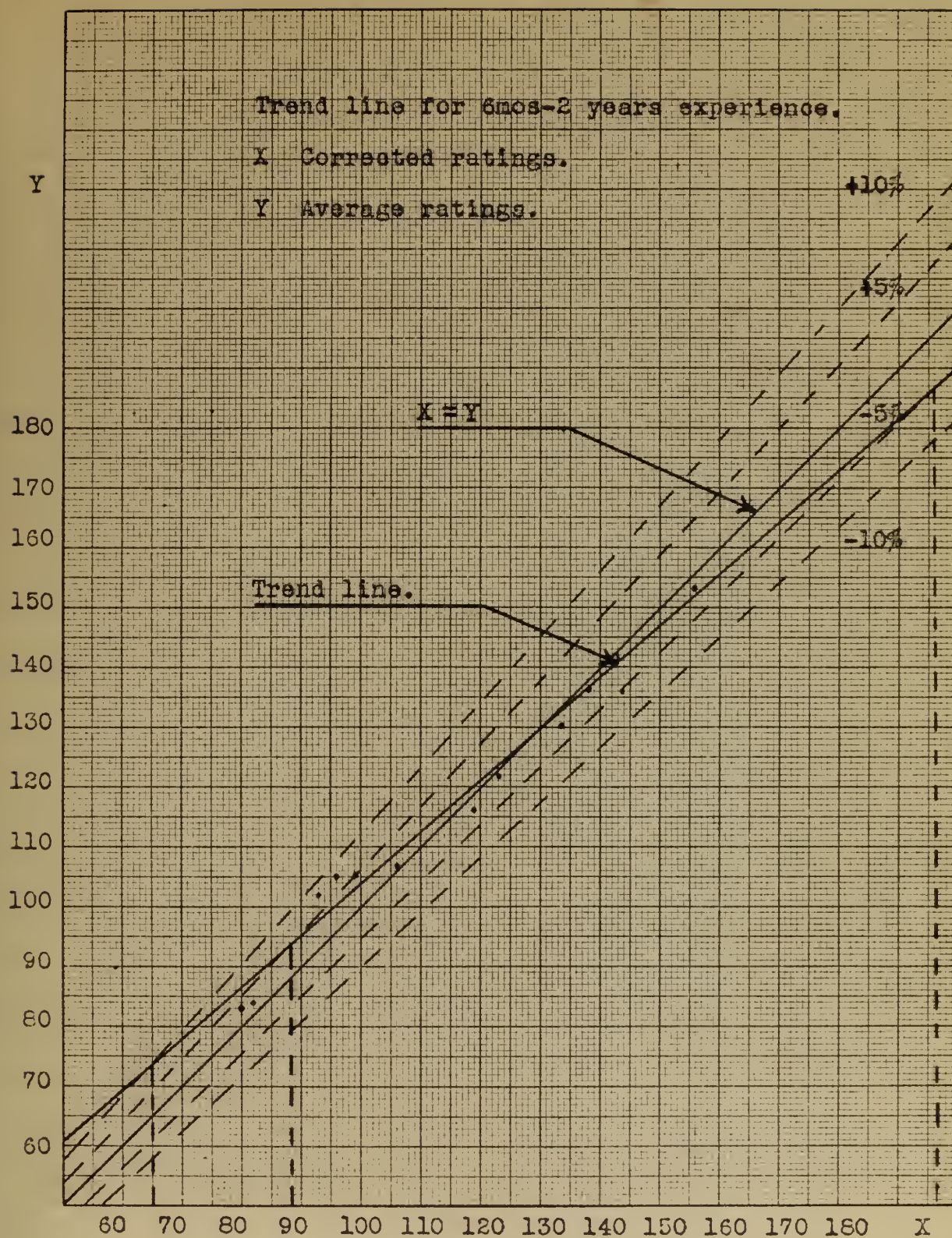


Fig. 7



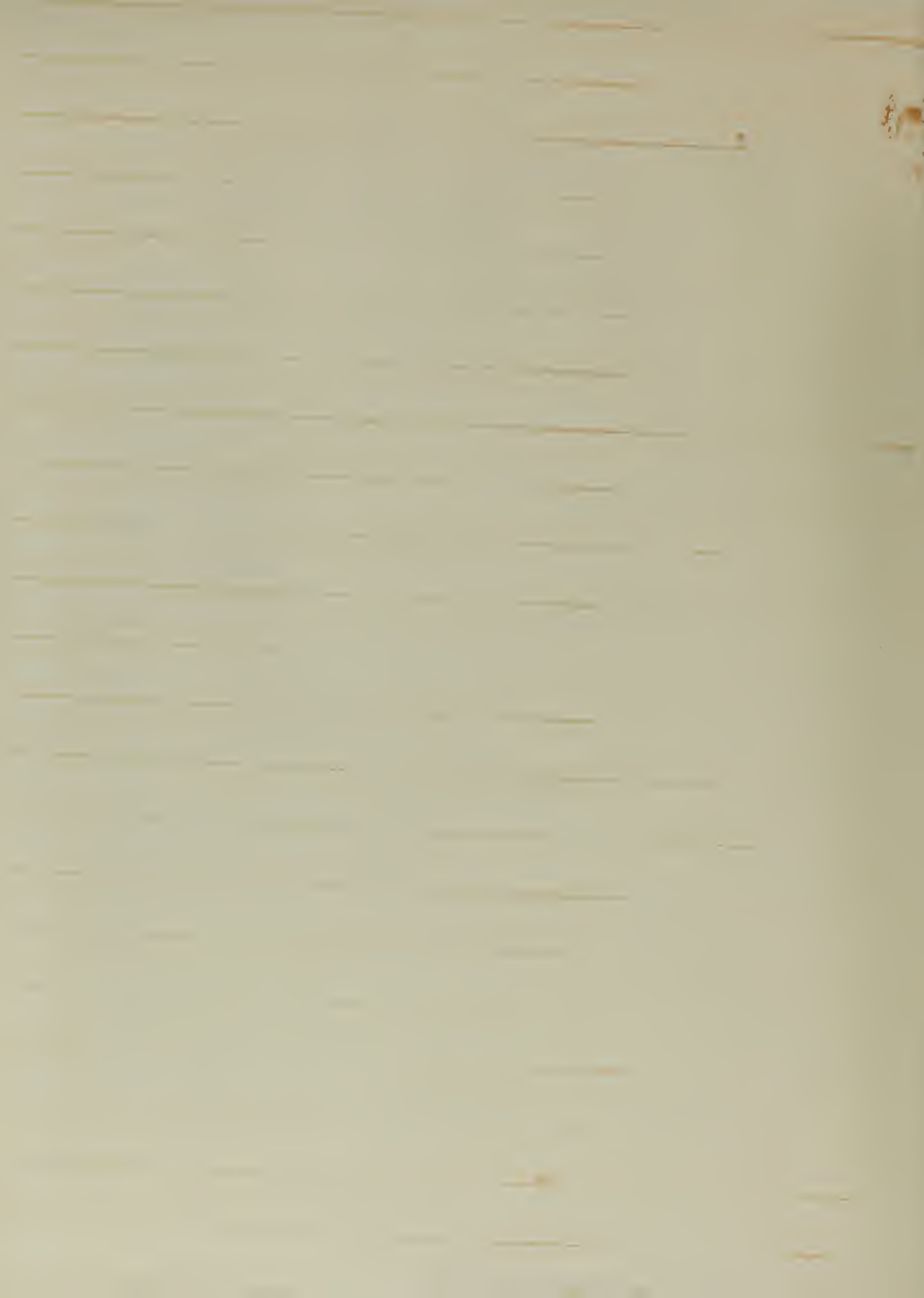


Fig. 8

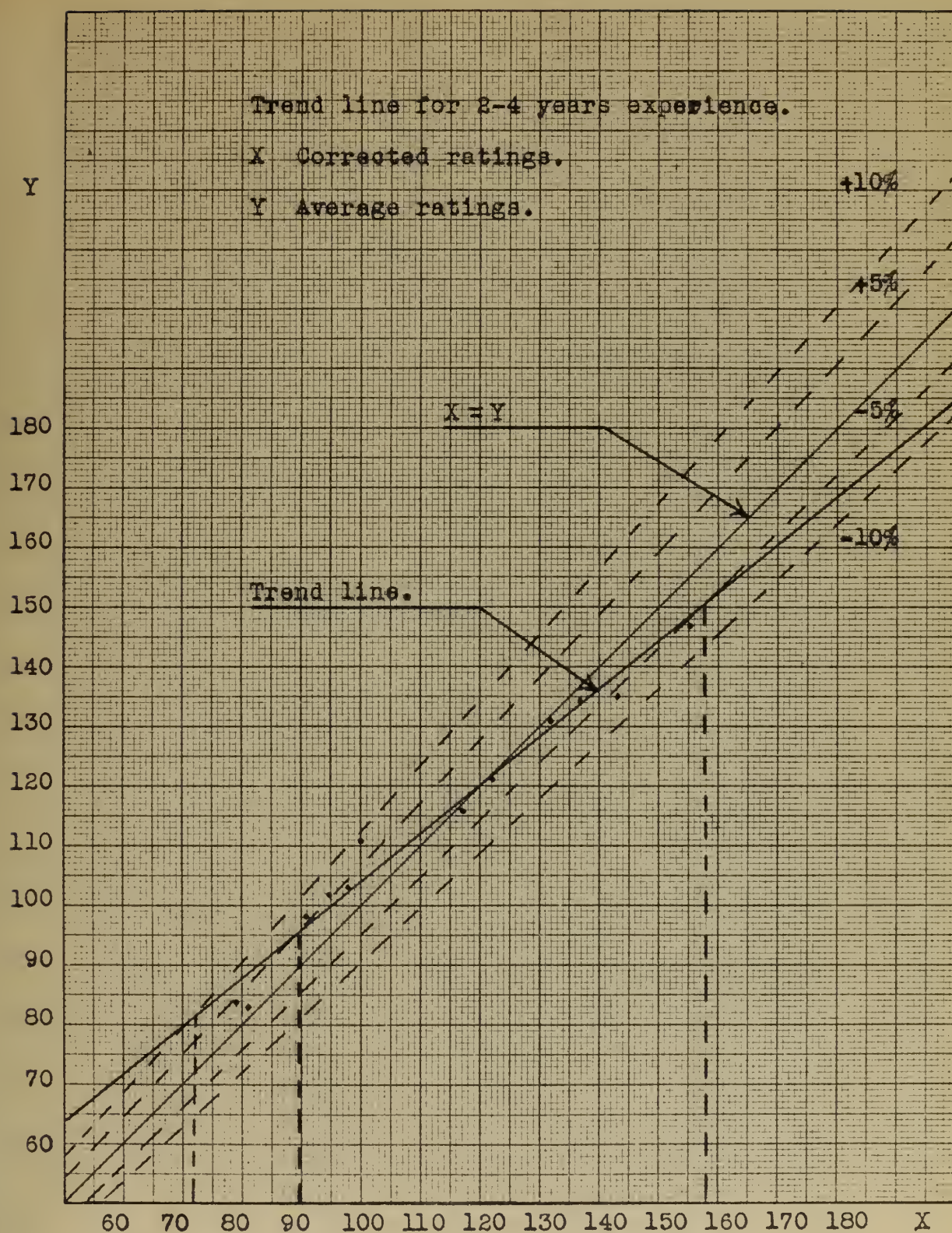


Fig. 9

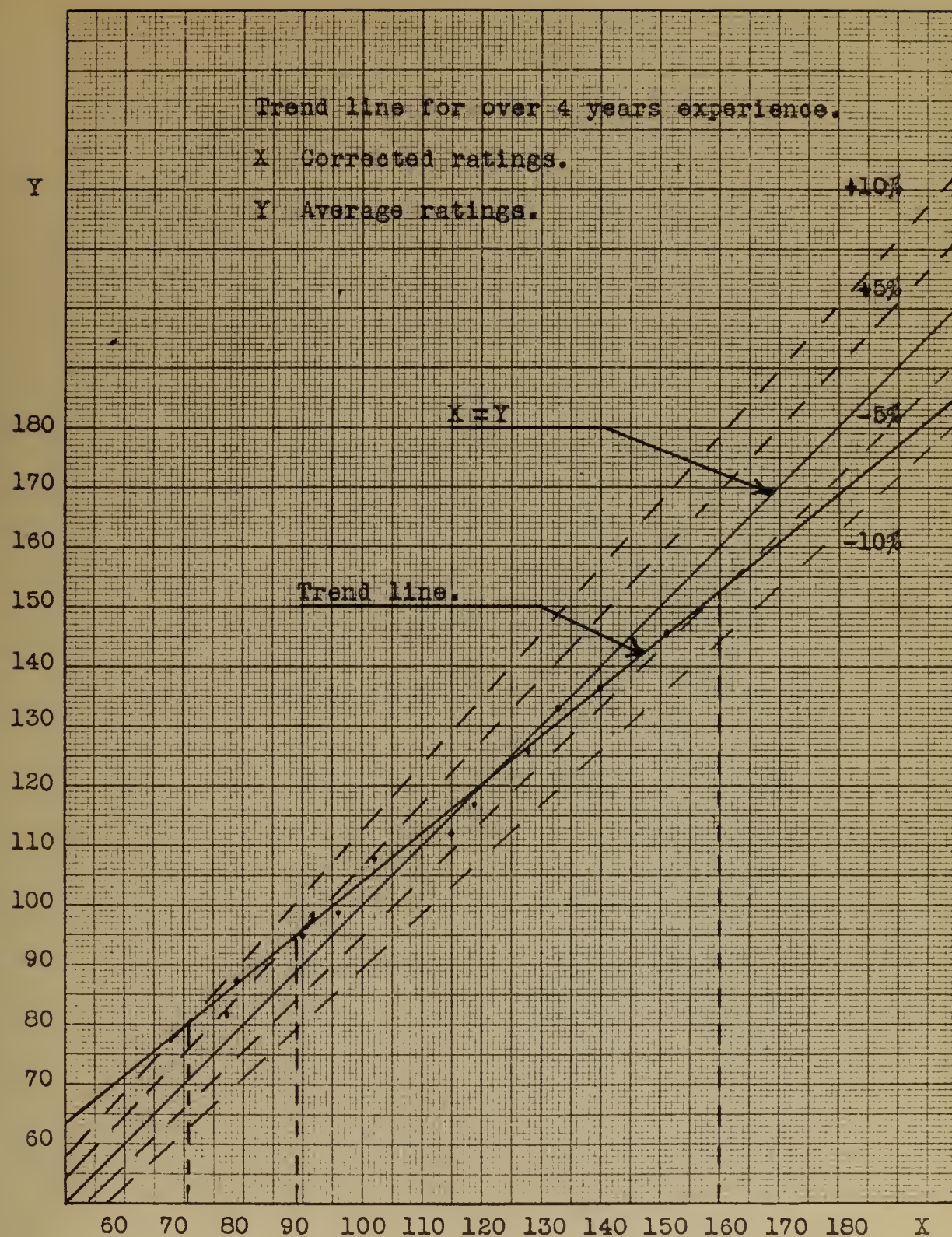


Fig. 10

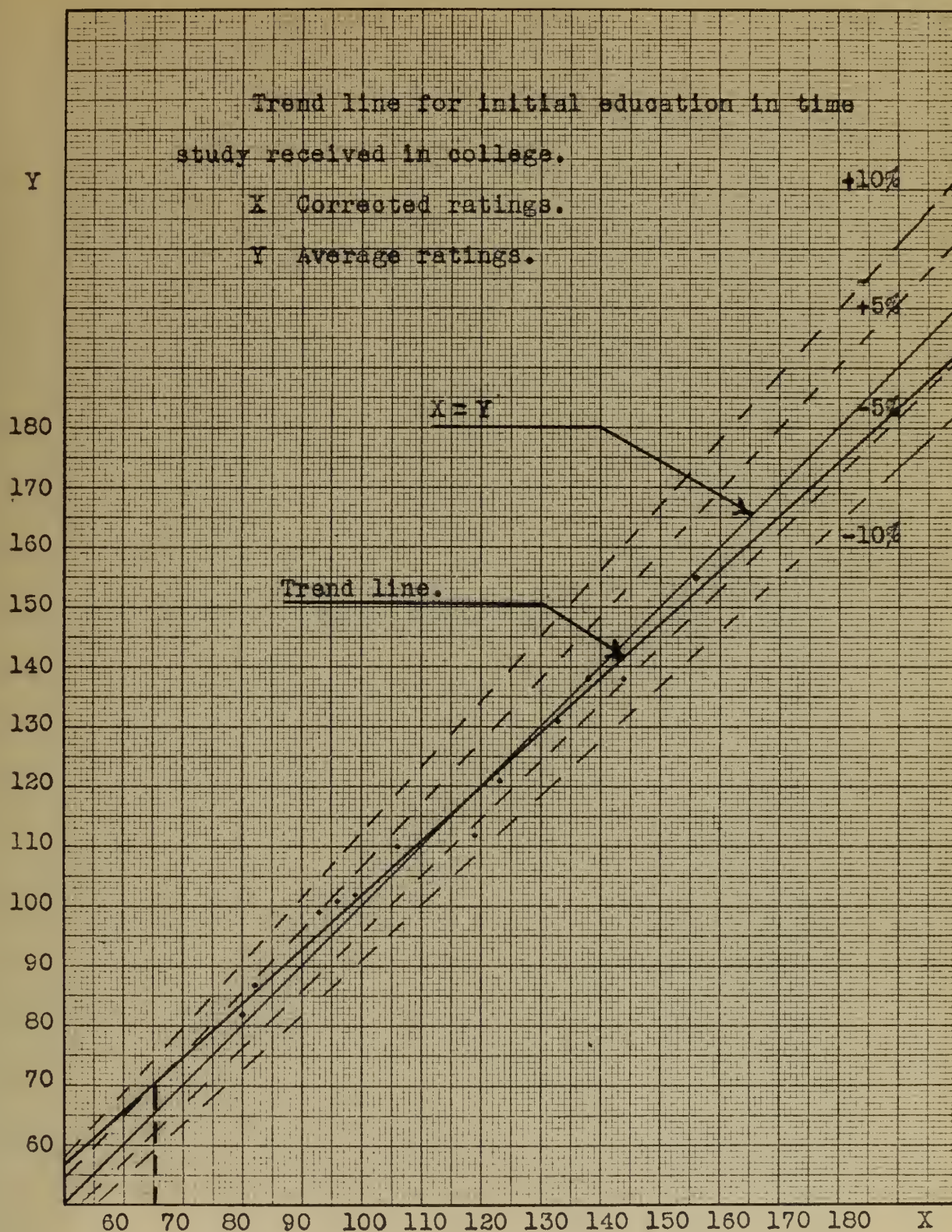


Fig. 11

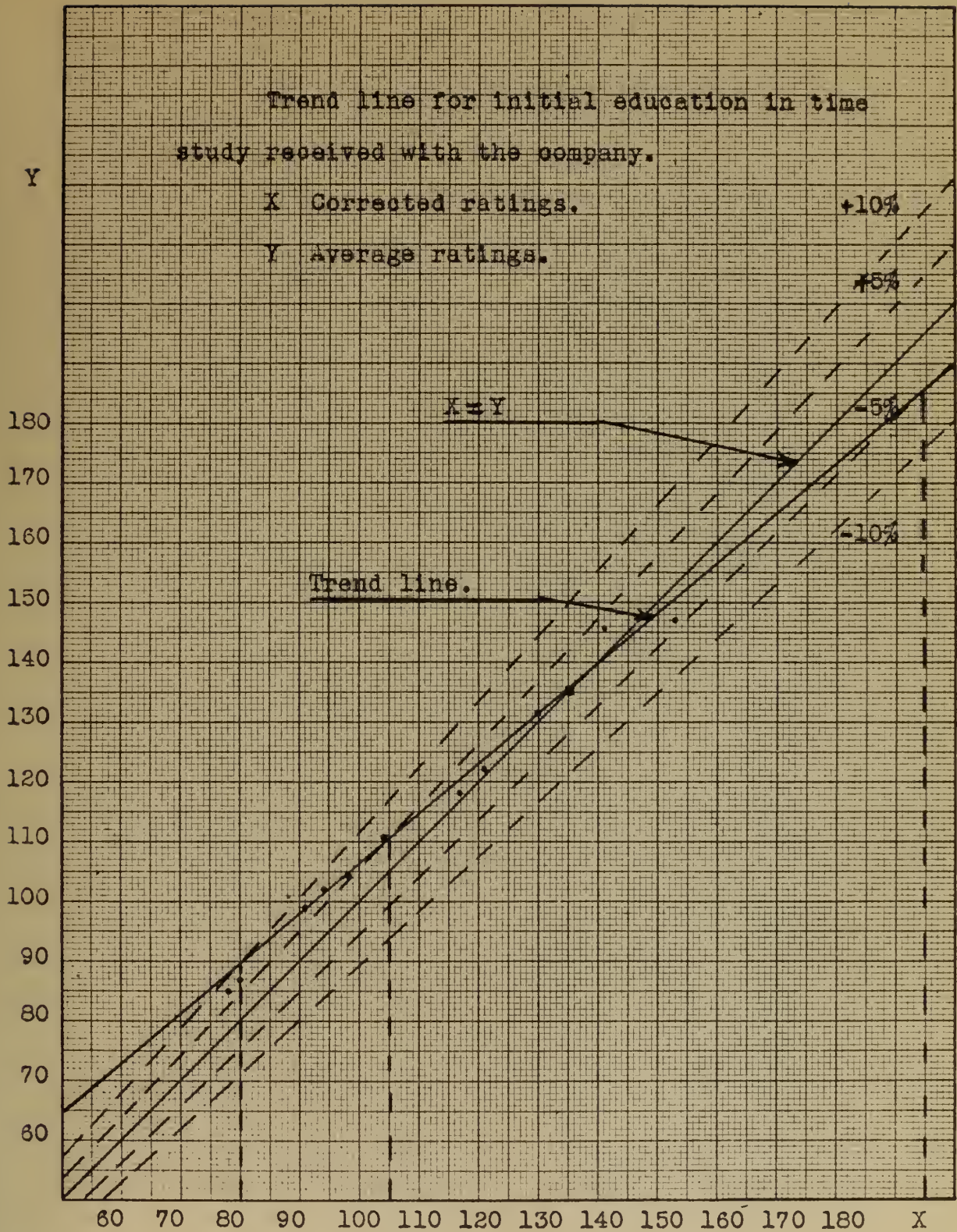


Fig. 12

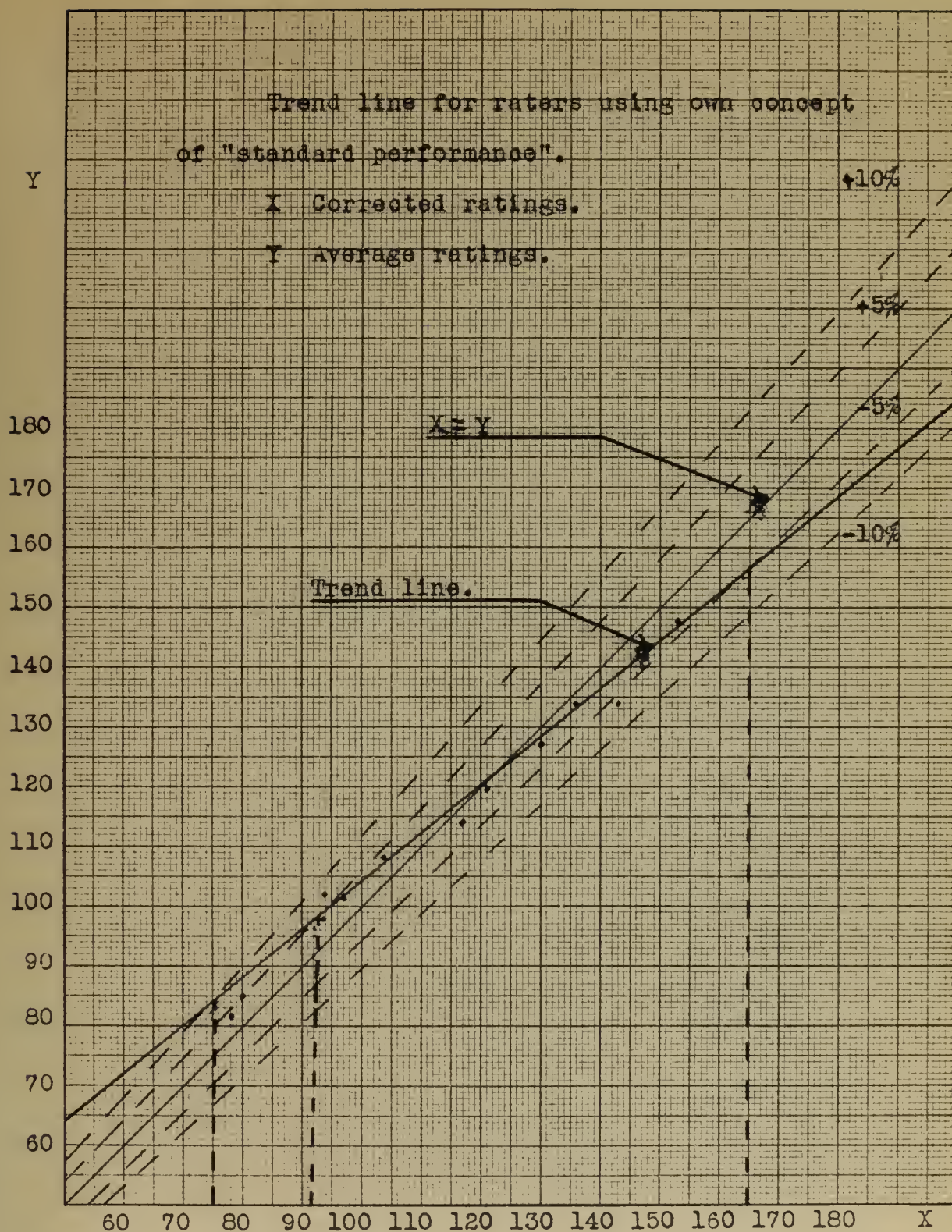


Fig. 13

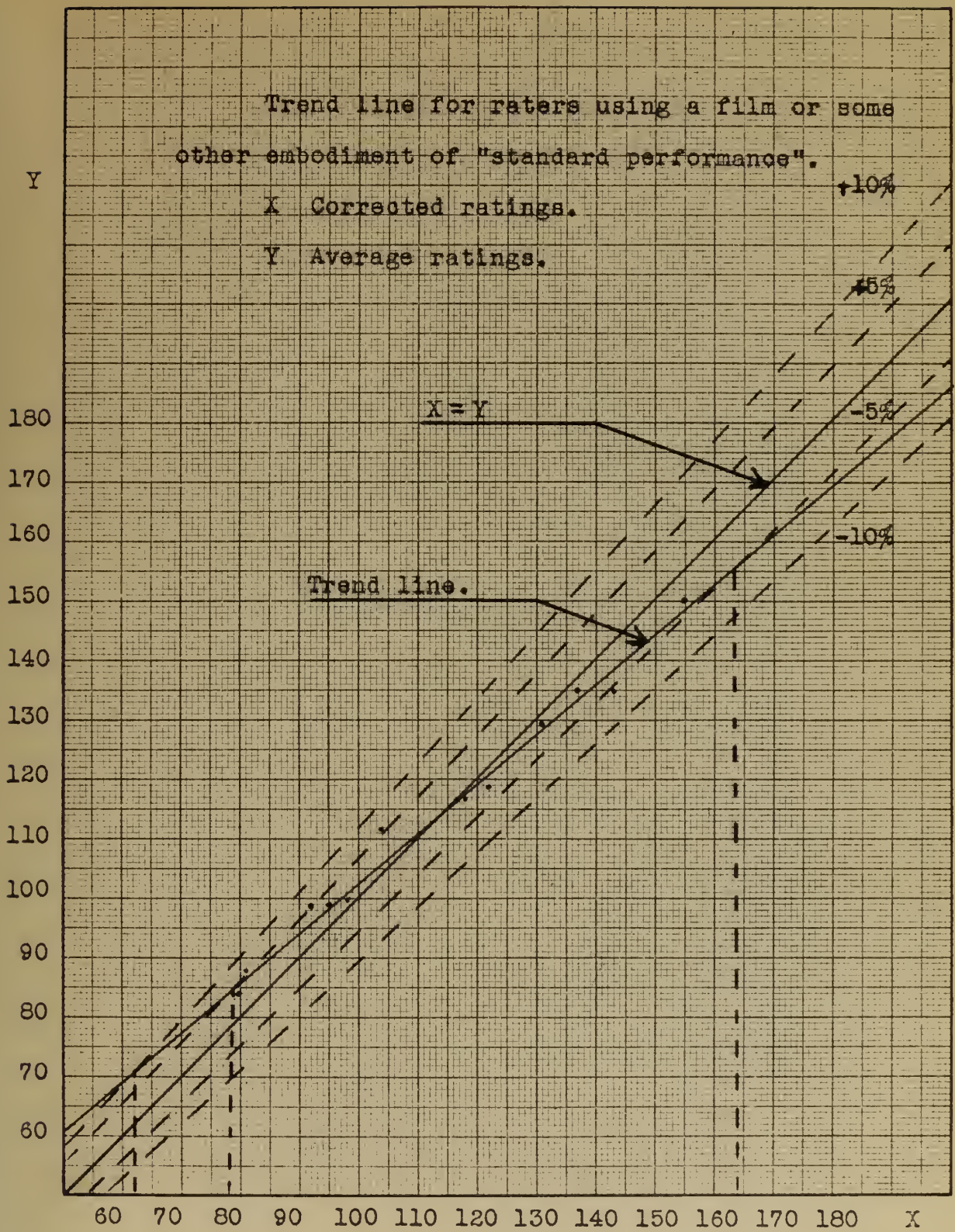


Fig. 14

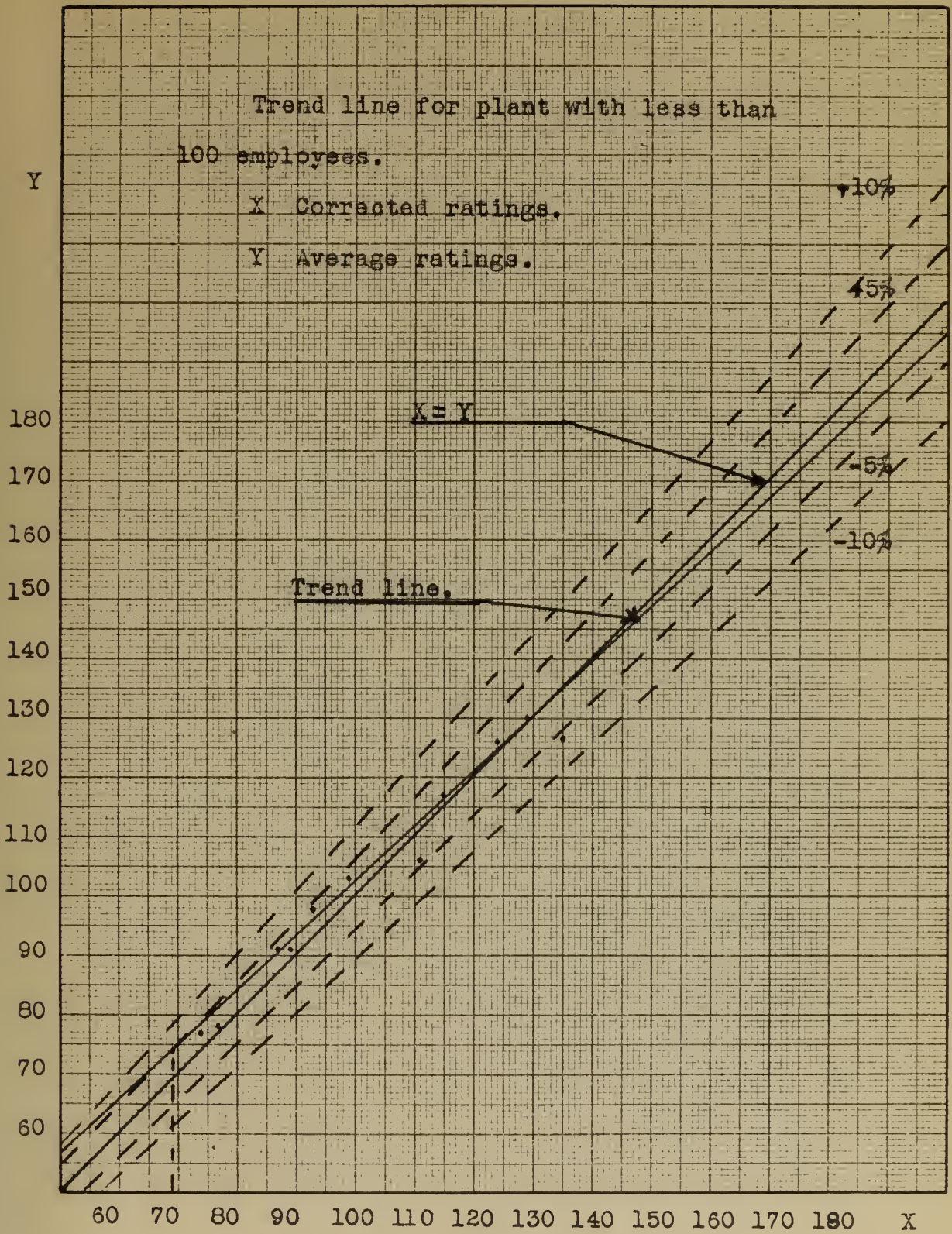


Fig. 15

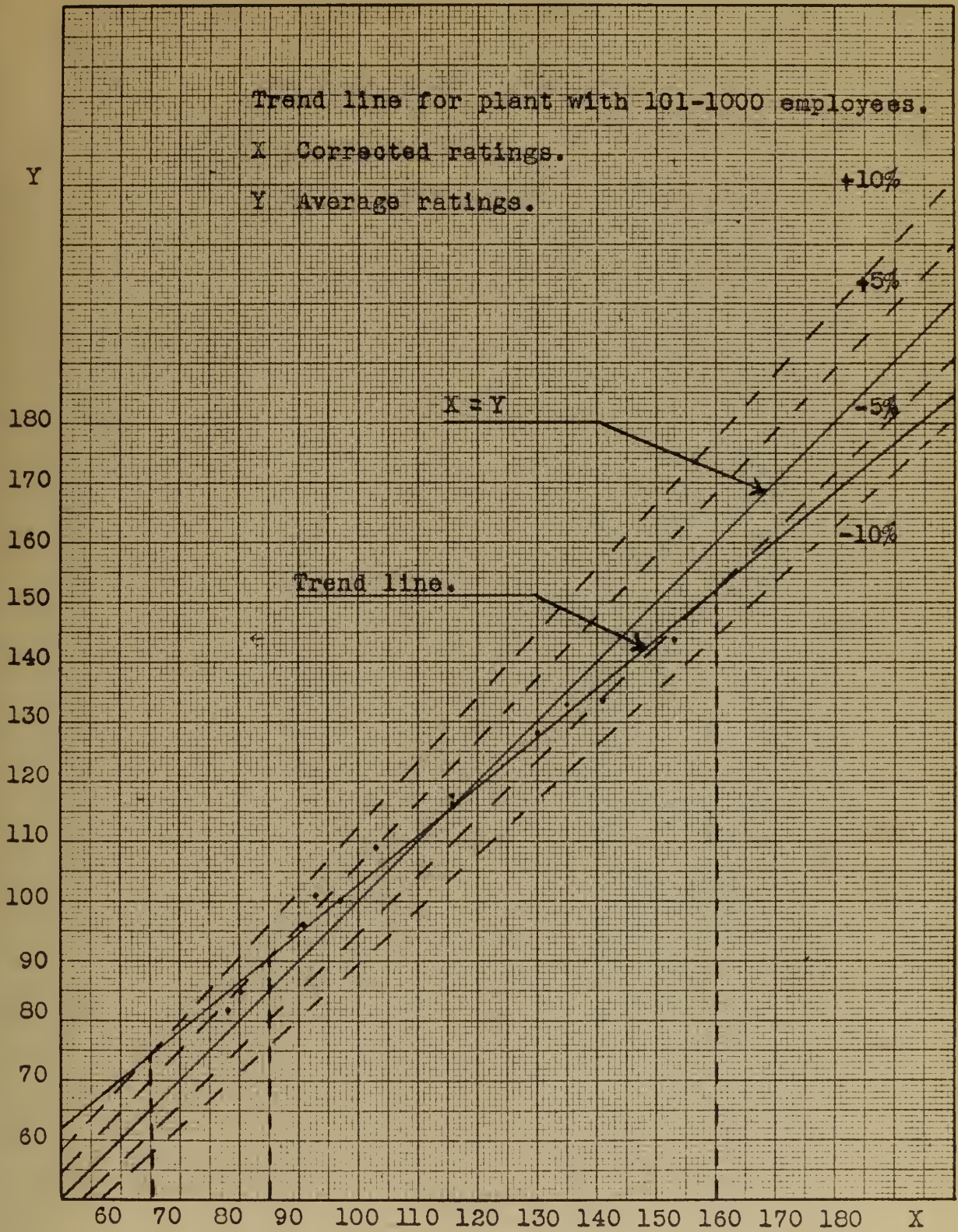


Fig. 16

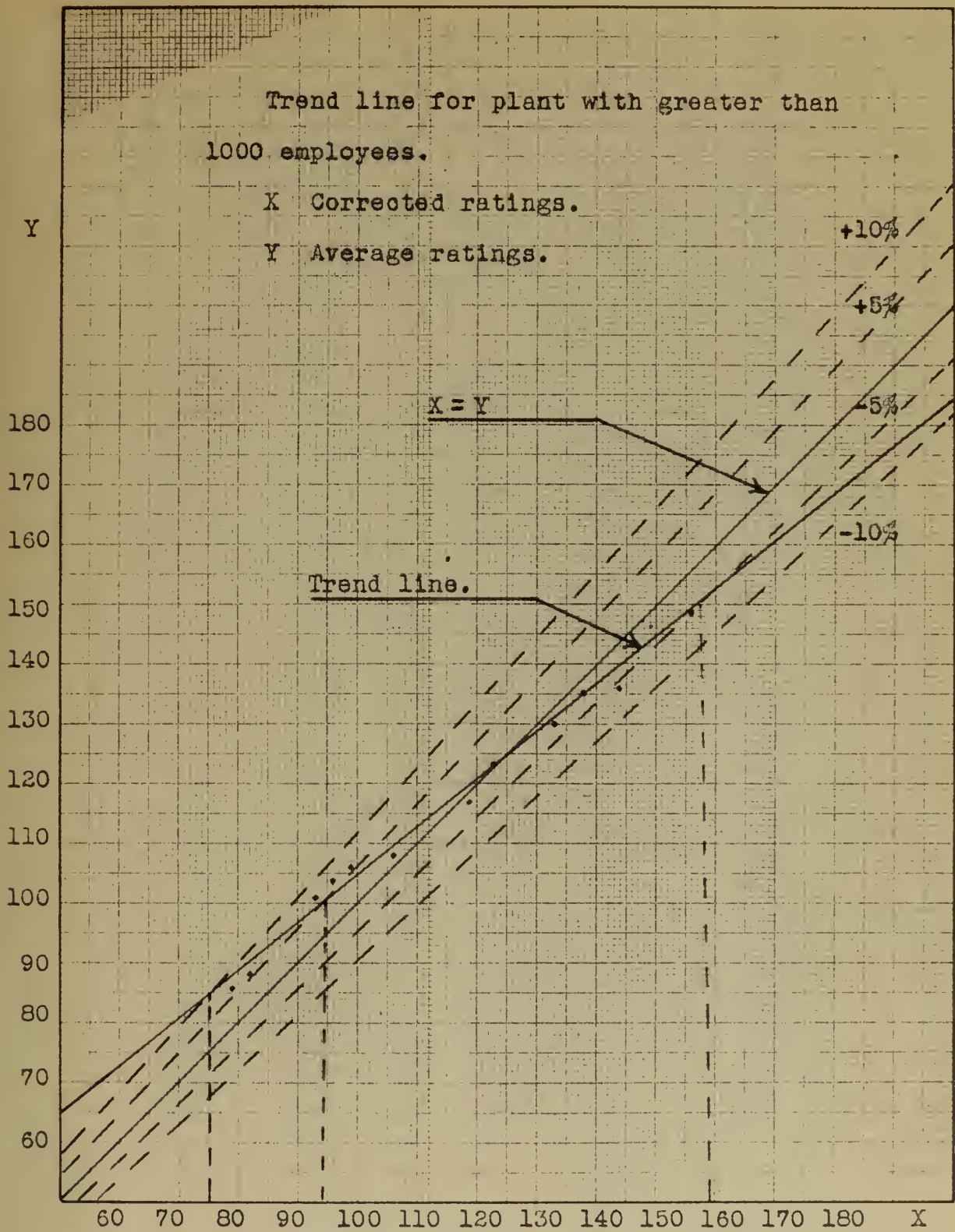


Fig. 17

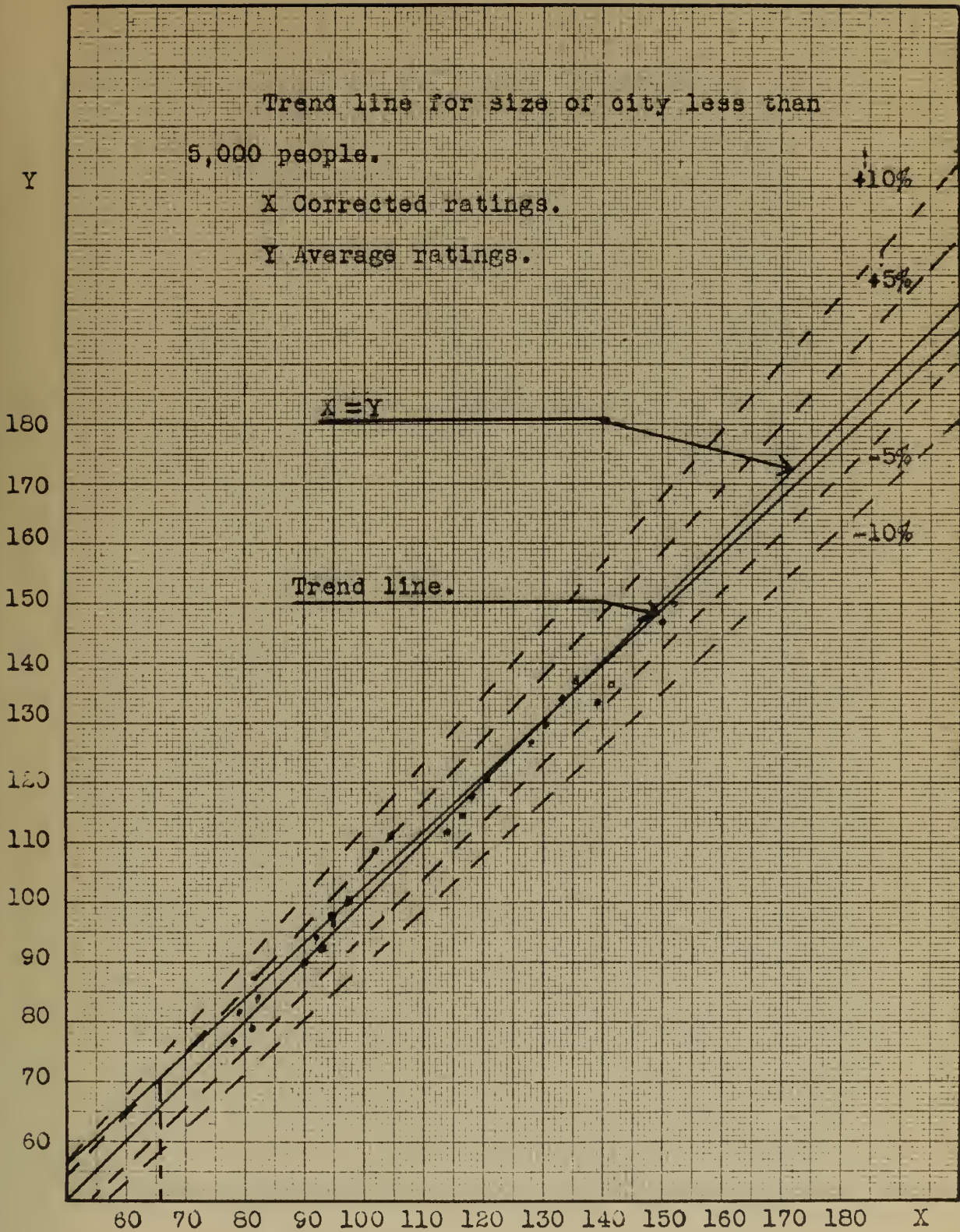


Fig. 18

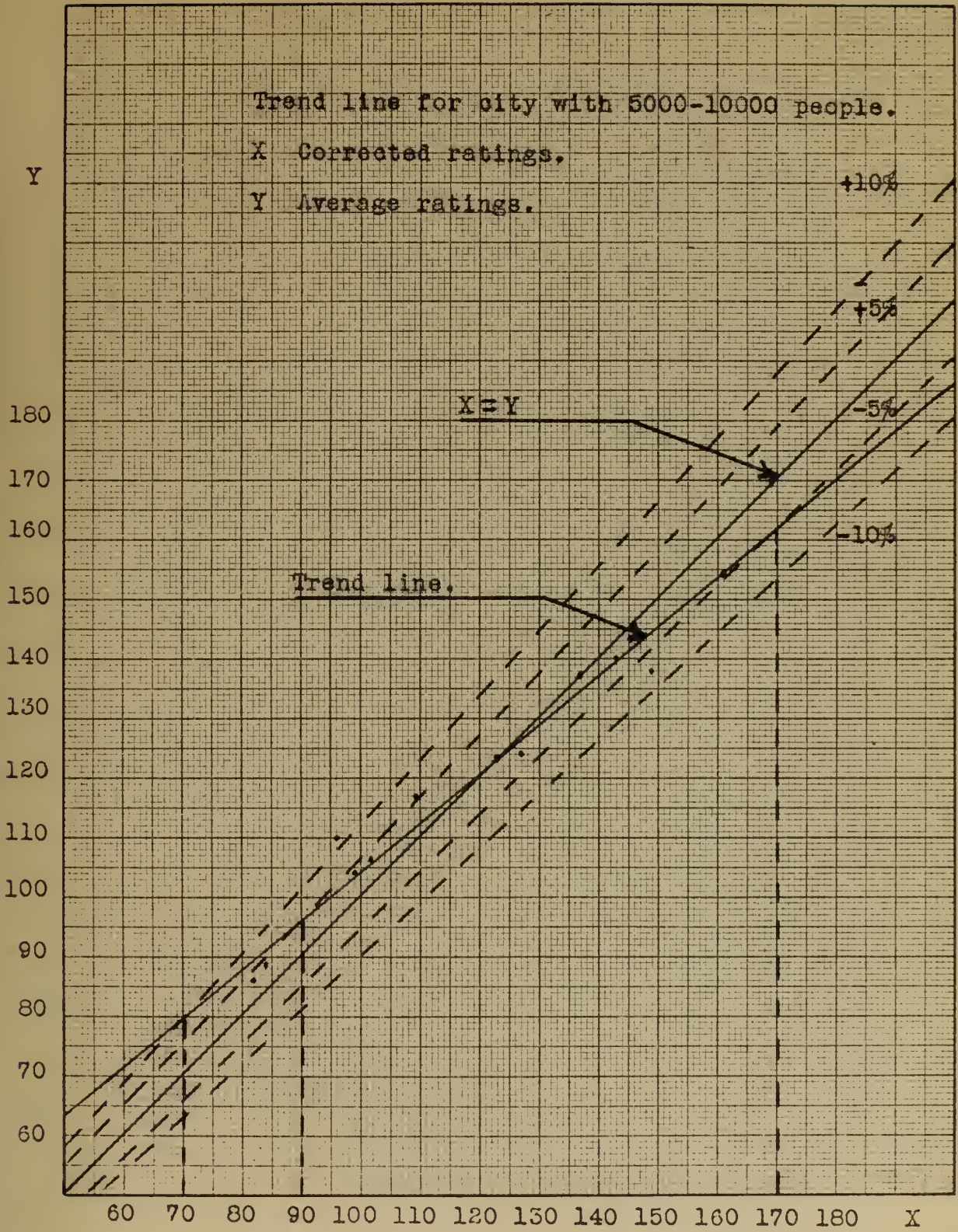


Fig. 19

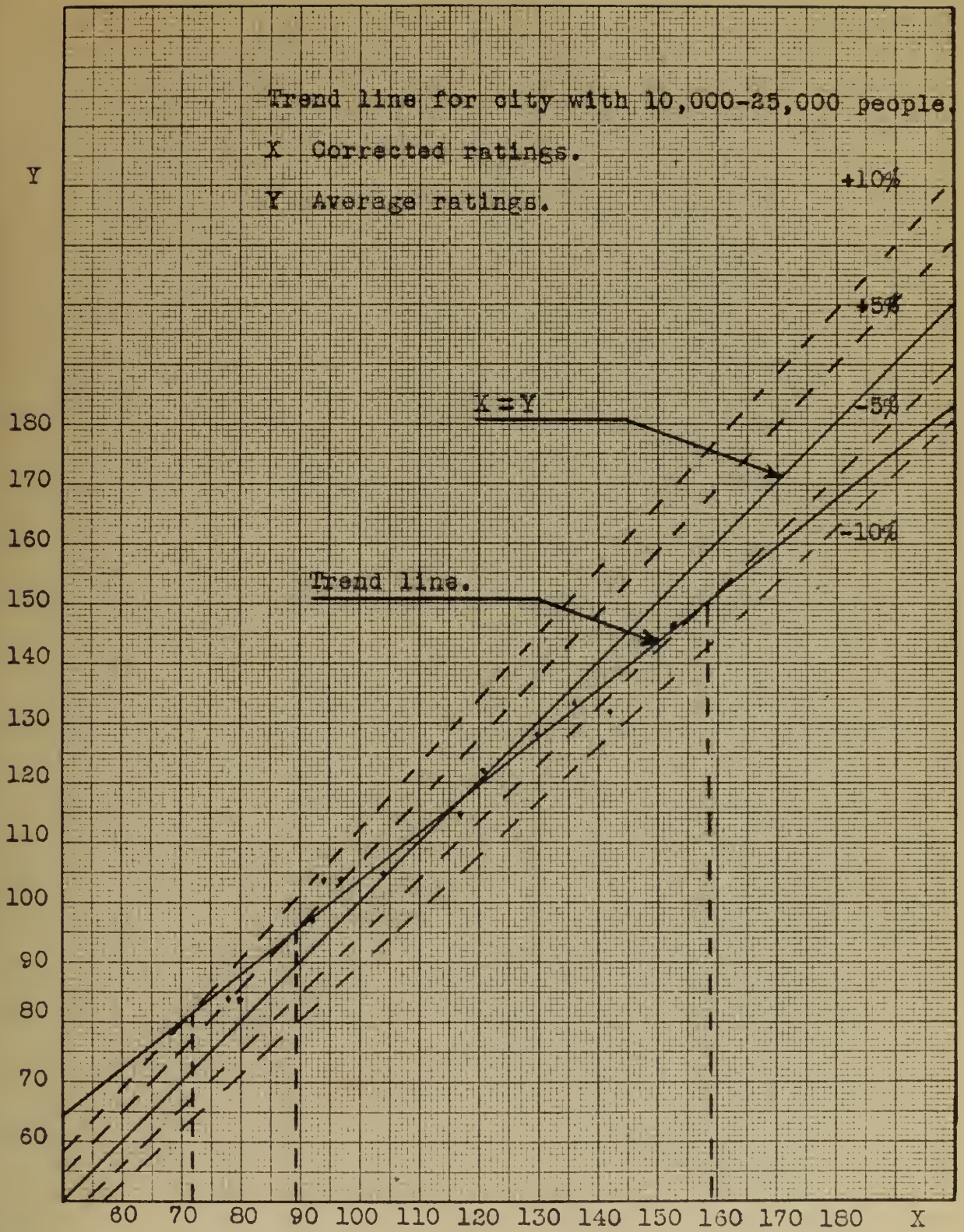


Fig. 20

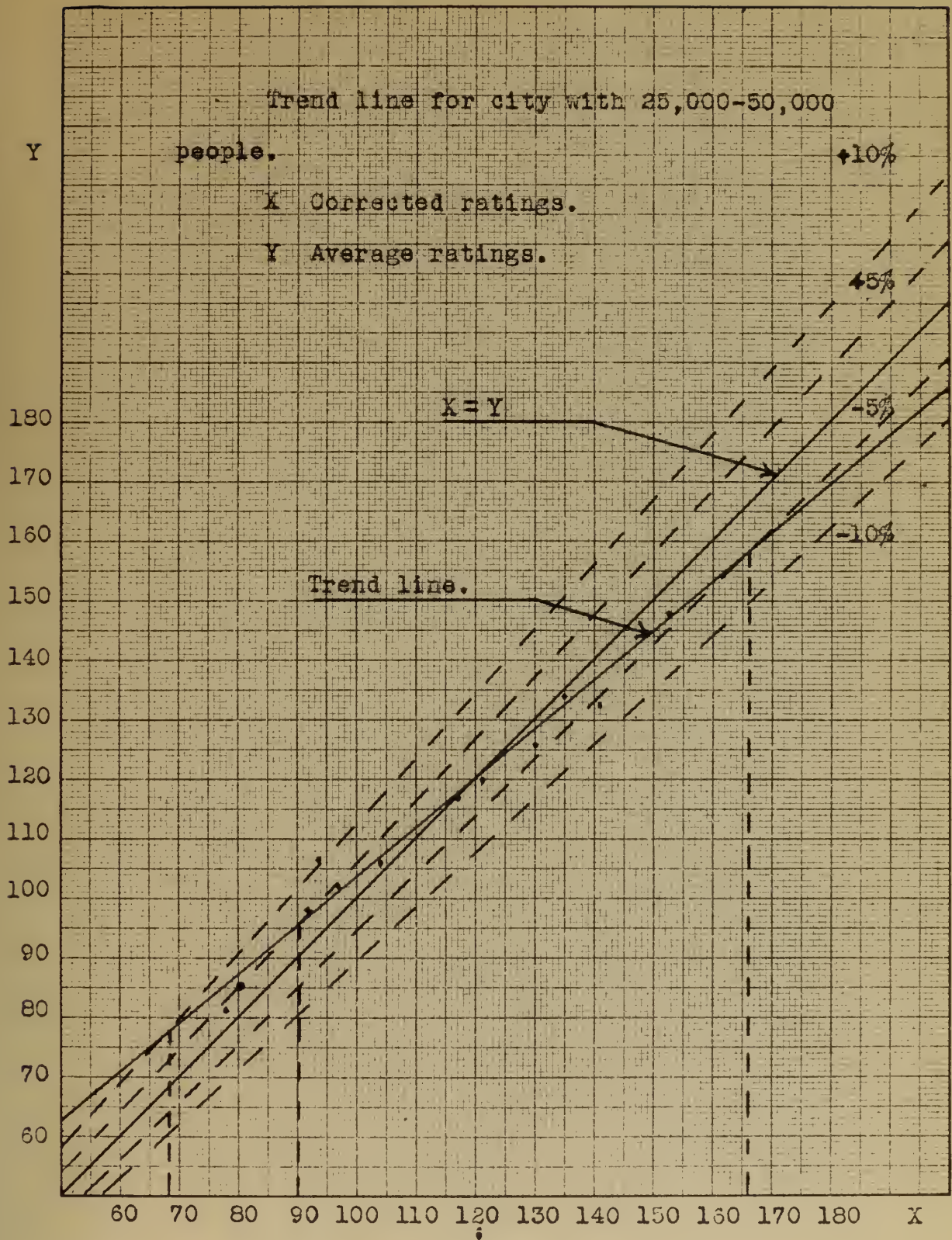


Fig. 21

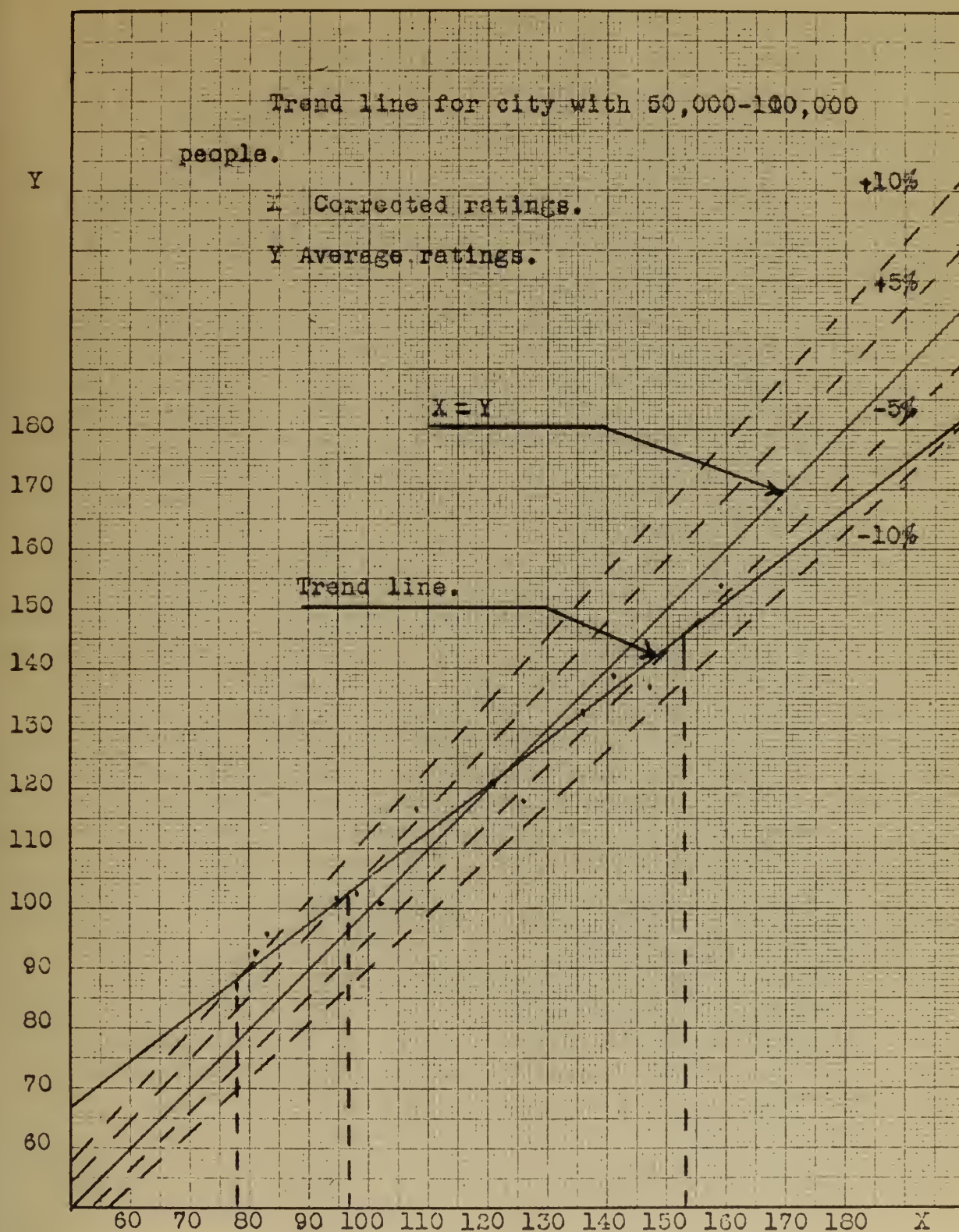


Fig. 22

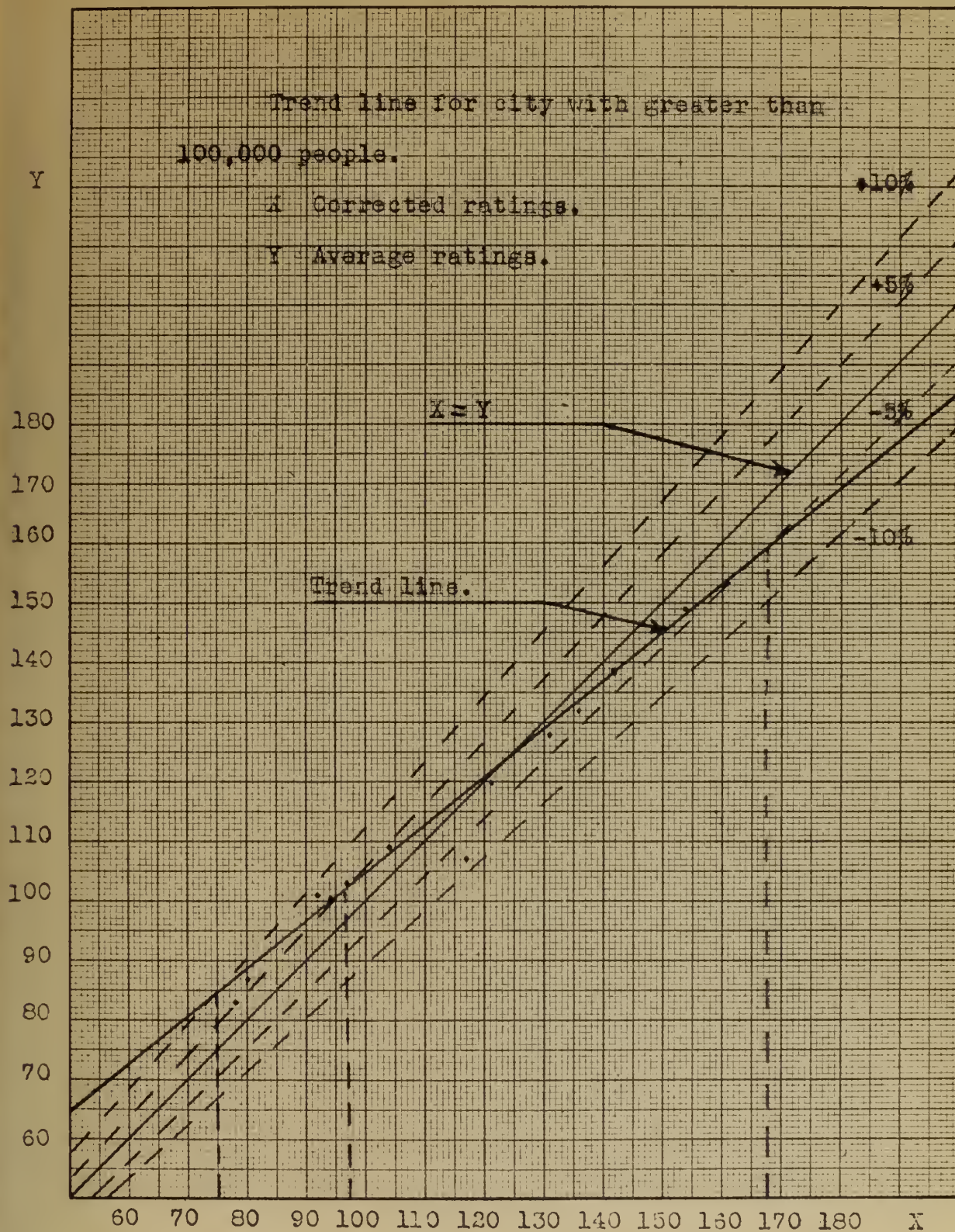


Fig. 23

Job description

Left hand.

Transport empty to pins.

Grasp one pin.

Transport loaded to scribe.

Position and transport

loaded past scribe.

Transport loaded to pin

release area.

Position and release load.

Right hand.

Hold scribe through

entire cycle.

Job description of the synthetic task: scribe end of
brass pins, using return chute.

Fig. 23

Job description

Right hand.

Hold scriber through

entire cycle.

Left hand.

Transport empty to pin.

Grasp one pin.

Transport loaded to scriber.

Position and transport

loaded past scriber.

Transport loaded to pin

release arm.

Position and release load.

Job description of the synthetic task: scriber end of

press pins, using return chute.

APPENDIX B

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MATHEMATICAL PROCEDURE

Mathematical procedures involved the computing of the true pace or "corrected rating" for each pace; the use of the "analysis-of-variance" technique, and fitting a line to a series of points by the method of "least squares". A short discussion on these procedures follow.

1. Computing the true pace or "corrected rating".

a. Designate "corrected rating" as X_n .

b. Obtain the average frame count per cycle for each pace. Designate the frame count as N_n .

c. To any one of the paces assign the value 100. Let this be pace number 10. Designate this as $X_{10}^1=100$.

d. Since each pace bears a fixed relationship to all other paces, the relationship being the ratio of their respective frame counts, we have the equation $X_n^1 \times N_n = C$, a constant. We now find X_n^1 for each pace from this equation and $X_{10}^1=100$.

e. The "corrected rating", X_n , bears the following relationship, $X_n = K X_n^1$, where K is a constant. A formula for deriving K will be given in a subsequent paragraph.

f. With the value of K determined, compute X_n .

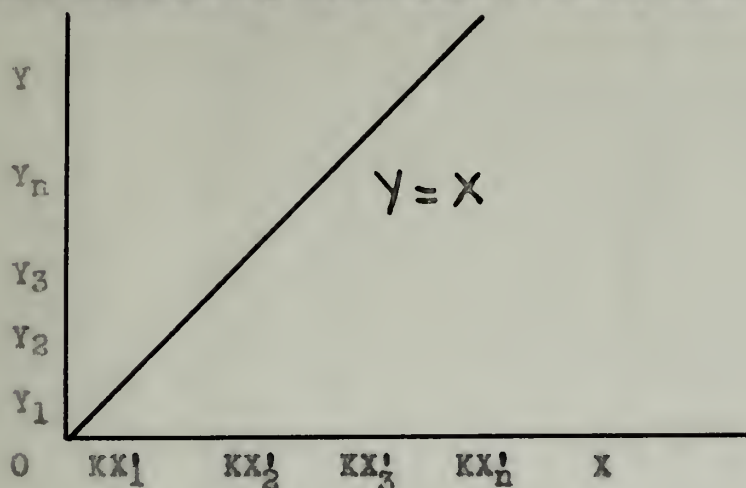
These values of X_n are in a direct ratio with each other according to their respective frame count per cycle, are related to the raters' average, and represent the nearest approach possible to a true rating.

MATHEMATICAL PROCEDURE

Mathematical procedures involved in computing of the true pace or "corrected rating" for each case; the use of the "analysis-of-variance" technique, and fitting a line to a series of points by the method of "least squares". A short discussion of these procedures follow.

1. Computing the true pace or "corrected rating".
 - a. Designate "corrected rating" as X_c .
 - b. Obtain the average frame count per cycle for each pace. Designate the frame count as N .
 - c. To any one of the paces assign the value 100. Let this be pace number 10. Designate this as $X_{10} = 100$.
 - d. Since each pace bears a fixed relationship to all other paces, the relationship being the ratio of their respective frame counts, we have the equation $X_c \times N_c = C$, a constant. We now find X_{10} for each pace from this equation and $N_{10} = 100$.
 - e. The "corrected rating", X_c , bears the following relationship, $X_c = K N_c$, where K is a constant. A formula for deriving K will be given in a subsequent paragraph.
 - f. With the value of K determined, compute X_c .
- These values of X_c are in a direct ratio with each other according to their respective frame count per cycle, are related to the ratings, average, and represent the nearest approach possible to a true rating.

Proof that $K = \frac{\sum_{i=1}^n X_i' Y_i}{\sum_{i=1}^n X_i'^2}$. This proof was derived by
 Dr. M. E. Mundel, Professor of Industrial Engineering,
 General Engineering Department, Purdue University.



Problem: To find the best set of X values about $Y = X$.

Given: X_1, X_2, \dots, X_n , the corrected ratings for each page.

$$X_1', X_2', \dots, X_n' = \frac{C}{N_n}$$

Y_1, Y_2, \dots, Y_n , the average of the raters' estimate for each page.

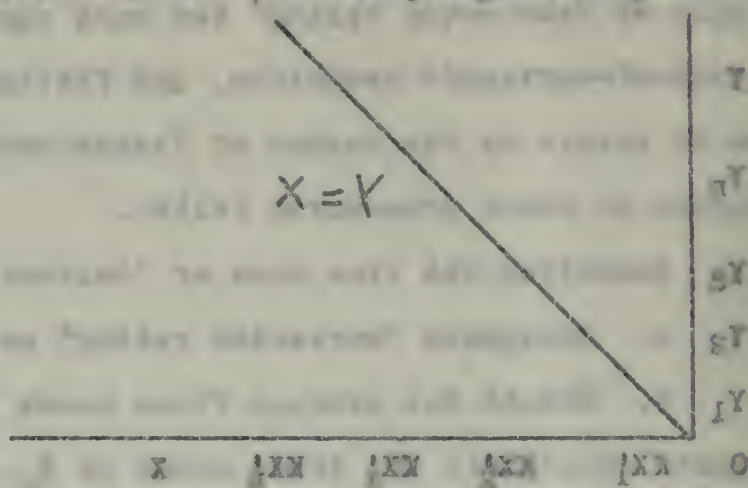
K is a constant to be selected such that $\sum d^2$ equals a minimum, where d is the variation about the line $Y = X$.

$$\text{Proof: } \sum d = (Y_1 - KX_1') + (Y_2 - KX_2') + \dots + (Y_n - KX_n')$$

$$\sum d^2 = Y_1^2 - 2KX_1'Y_1 + K^2X_1'^2 + \dots + (Y_n - KX_n')^2$$

The value of K which will permit $\sum d^2$ to be a minimum is obtained by setting the partial derivative of $\sum d^2$ with

Dr. W. E. Arnold, Professor of Industrial Engineering,
General Engineering Department, Purdue University.



Problem: To find the best set of X values about $Y=X$.

Given: X_1, X_2, \dots, X_n , the corrected ratings for

each page.

$$X'_1, X'_2, \dots, X'_n = \frac{X_i}{n}$$

Y_1, Y_2, \dots, Y_n , the average of the ratings

estimate for each page.

K is a constant to be selected such that $\sum d^2$

equals a minimum, where d is the variation about the line

Proof: $\sum d = (Y_1 - KX'_1) + (Y_2 - KX'_2) + \dots + (Y_n - KX'_n)$.

$$\sum d^2 = Y_1^2 - 2KX'_1Y_1 + K^2X'^2_1 + \dots + Y_n^2 - 2KX'_nY_n + K^2X'^2_n$$

The value of K which will permit $\sum d^2$ to be a minimum is

obtained by setting the partial derivative of $\sum d^2$ with

Proof that $\sum d^2$ is a minimum

respect to K equal to 0 and solving for K .

$$\frac{\partial \sum d^2}{\partial K} = -2K_1'Y_1 + 2KX_1'^2 - \dots - 2K_n'Y_n + 2KX_n'^2 = 0.$$

Solving for K we have,

$$K = \frac{X_1'Y_1 + X_2'Y_2 + \dots + X_n'Y_n}{X_1'^2 + X_2'^2 + \dots + X_n'^2}.$$

$$K = \frac{\sum_{i=1}^n X_i'Y_i}{\sum_{i=1}^n X_i'^2}.$$

2. Analysis-of-variance technique.

Details of the analysis-of-variance tests are not presented here¹⁰ but it can be shown that if we have the variable X arranged in the following manner,

X_{11}	$X_{12} \dots X_{1j} \dots X_{1b}$	$\bar{X}_{1.}$
X_{21}	$X_{22} \dots X_{2j} \dots X_{2b}$	$\bar{X}_{2.}$
\vdots	\vdots	\vdots
X_{i1}	$X_{i2} \dots X_{ij} \dots X_{ib}$	$\bar{X}_{i.}$
\vdots	\vdots	\vdots
\vdots	\vdots	\vdots
X_{a1}	$X_{a2} \dots X_{aj} \dots X_{ab}$	$\bar{X}_{a.}$
$\bar{X}_{.1}$	$\bar{X}_{.2} \dots \bar{X}_{.j} \dots \bar{X}_{.b}$	\bar{X}

and if we assume these values of X are random sample values from a normal population with mean m and variation σ^2 ,

¹⁰ Paul G. Hoel, Introduction to Mathematical Statistics, p. 154-161, John Wiley & Sons, Inc., New York, 1949.

value from a normal population with mean μ and variance σ^2 and if we assume these values of X are random sample

\bar{X}_1	$X_{11} \dots X_{1n_1}$	\bar{X}_1
\bar{X}_2	$X_{21} \dots X_{2n_2}$	\bar{X}_2
\vdots	\vdots	\vdots
\bar{X}_k	$X_{k1} \dots X_{kn_k}$	\bar{X}_k
\vdots	\vdots	\vdots
\bar{X}_r	$X_{r1} \dots X_{rn_r}$	\bar{X}_r
\bar{X}	$X_{11} \dots X_{rn_r}$	\bar{X}

I arranged in the following manner, but it can be shown that if we have the variable
 Details of the analysis-of-variance tests are not given
 3. Analysis-of-variance technique.

$$\frac{\sum_{i=1}^r \sum_{j=1}^{n_i} (X_{ij} - \bar{X})^2}{\sum_{i=1}^r \sum_{j=1}^{n_i} (X_{ij} - \bar{X}_i)^2 + \sum_{i=1}^r (n_i - 1) \bar{X}_i^2}$$

$$= \frac{X_{11}^2 + X_{12}^2 + \dots + X_{1n_1}^2 + X_{21}^2 + X_{22}^2 + \dots + X_{2n_2}^2 + \dots + X_{r1}^2 + X_{r2}^2 + \dots + X_{rn_r}^2}{X_{11}^2 + X_{12}^2 + \dots + X_{1n_1}^2 + X_{21}^2 + X_{22}^2 + \dots + X_{2n_2}^2 + \dots + X_{r1}^2 + X_{r2}^2 + \dots + X_{rn_r}^2}$$

obtaining for K we have,

$$\frac{9}{6} = \frac{-2X_{11}^2 + 2X_{12}^2 + 2X_{13}^2 - \dots - 2X_{1n_1}^2 + 2X_{21}^2 + 2X_{22}^2 + \dots + 2X_{2n_2}^2}{6}$$

respect to K equal to 0 and solving for K .

$$\text{then } F_c = \frac{a \sum_{j=1}^b (\bar{X}_{.j} - \bar{X})^2 (a-1)(b-1)}{\sum_{i=1}^a \sum_{j=1}^b (X_{ij} - \bar{X}_{i.} - \bar{X}_{.j} + \bar{X})^2 (b-1)}.$$

The numerator, with $(b-1)$ degrees of freedom, measures variation between columns. The denominator, with $(a-1)(b-1)$ degrees of freedom, measures the "experimental error", that is, variation in the fundamental variable after row and column effects have been eliminated.

In this thesis, a is the number of paces, b is the number of breakdowns, X is the percentage of raters within $\pm 5\%$ of the corrected rating or any designated level of accuracy.

F_c was computed at the $\pm 5\%$ and $\pm 10\%$ levels of accuracy for each category of breakdown and was compared with the tabular value of F at the 5% level of significance.

3. Fitting a curve to a set of points by the method of "least squares".

Details of the method of "least squares" will not be presented here but involves the use of the following equations.¹¹

$$\sum Y = aN + m \sum X.$$

$$\sum XY = a \sum X + m \sum X^2.$$

a = intercept, m = slope.

With the values of a and m determined we substitute them in the general equation for a straight line, $Y = mX + a$, and obtain the line best fitting the available points.

¹¹ Ibid., p. 79.

$$\text{then } r_c = \frac{\sum_{j=1}^p (\bar{X}_j - \bar{X})^2 - \frac{(\sum_{j=1}^p (\bar{X}_j - \bar{X}))^2}{p-1}}{\sum_{j=1}^p (\bar{X}_j - \bar{X})^2 + \frac{(\sum_{j=1}^p (\bar{X}_j - \bar{X}))^2}{p-1}}$$

The numerator, with $(p-1)$ degrees of freedom, measures variation between columns. The denominator, with $(s-1)(p-1)$ degrees of freedom, measures the "experimental error", that is, variation in the fundamental variable after row and column effects have been eliminated.

In this thesis, s is the number of pages, p is the number of breakdowns, X is the percentage of rats within $\pm 5\%$ of the corrected rating or any designated level of accuracy.

r_c was computed at the $\pm 5\%$ and $\pm 10\%$ levels of accuracy for each category of breakdown and was compared with the tabular value of r at the 5% level of significance.

3. Fitting a curve to a set of points by the method of

"least squares".

Details of the method of "least squares" will not be presented here but involves the use of the following equations. 11

$$\sum Y = n + m \sum X$$

$$\sum XY = n \bar{X} + m \sum X^2$$

a = intercept, m = slope.

With the values of a and m determined we substitute them

in the general equation for a straight line, $Y = mX + a$, and

obtain the line best fitting the available points.

BIBLIOGRAPHY

Barnes, R. M., Motion and Time Study, 3rd ed., John Wiley & Sons, Inc., New York, 1949.

Borrus, B. S., "The Present State of Time Study", Unpublished Masters Thesis, Purdue University, 1950.

Hoel, P. G., Introduction to Mathematical Statistics, John Wiley & Sons, Inc., New York, 1949.

Lehrer, R. W., "Development and Evaluation of a Pace Scale for Time Study Rating", Unpublished Doctors Thesis, Purdue University, 1949.

Margolin, Louis, "A Comparison of The Methods of Presentation for Time Study Rating", Unpublished Masters Thesis, Purdue University, 1948.

Mundel, M. E. Systematic Motion and Time Study, Prentice-Hall, Inc., New York, 1947.

Presgrave, Ralph, Dynamics of Time Study, 2nd ed., McGraw Hill Book Co., Inc., New York, 1945.

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